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THE FLORA OF THE EAGLE CREEK FORMATION

BY
RALPH W. CHANEY

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INTRODUCTION

During the seasons of 1916 and 1917 considerable collections of fossil plant material were made by the writer in the Gorge of the Columbia River, in Oregon and Washington. The Tertiary floras of the Pacific Coast region are so little known that it has seemed desirable to make a thorough study of this material. And while no collections can ever be complete, a sufficiently representative group of fossil plants has been studied to make possible conclusions, not only regarding the age of the formation in which they occur, but regarding the general character of the flora and the physical conditions during the epoch.

Acknowledgment is made to Dr. J H. Bretz, of the University of Chicago, who first directed the writer's attention to this field, and who is responsible for the discovery of one of the most important plant-bearing deposits. I am indebted also to Dr. F. H. Knowlton for valuable advice and assistance in determining species, and to Dr. H. C. Cowles, of the University of Chicago, for his direction in the interpretation of the ecological data. The work during the season of 1917 was carried on with the aid of a grant from the Research Fund of the American Association for the Advancement of Science, to which organization sincere acknowledgment is due.

GEOGRAPHICAL LOCATION AND TOPOGRAPHIC FEATURES OF THE COLUMBIA GORGE

The gorge of the Columbia River is that portion of its valley in the Cascade Range. Its general features are shown in the Mount Hood sheet of the United States Geological Survey, where the Columbia River forms the boundary between Oregon and Washington. The river has exposed here a section which has a maximum thickness of over 4,000 feet. The basal Eagle Creek formation is displayed at the axis of the range, giving the most complete section just west of the boundary between Multnomah and Hood River counties. The total length of the Gorge from Troutdale, Oregon,

on the west to The Dalles, Oregon, on the east is about 70 miles. Its width averages about one mile.

The walls of the Gorge rise steeply, especially on the Oregon side, where cliffs of basalt rise more than 2,000 feet almost vertically. A number of peaks, some of them representing volcanic cones, lie a short distance back from the edge of the walls. Larch Mountain, 4,045 feet, and Mount Defiance, 4,960 feet, are conspicuous examples. Numerous small tributary streams flow into the Columbia from each side through canyons which are much shallower than that of the master-stream. As a result each has at or near its mouth a falls or series of falls, the highest being Multnomah Falls, 620 feet high, at the mouth of Multnomah Creek. The sections exposed in the lower stretches of these tributaries add much to our knowledge of the stratigraphy and fossil content of the rocks.

The western two-thirds of the Gorge is occupied by the luxuriant forest of Douglas spruce so characteristic of the Pacific Coast. Much of the geologic record is hidden by the density of this forest and its undergrowth. The best accessible sections are found where the building of roads and trails has temporarily destroyed the vegetation cover. Conditions become progressively more arid toward the east, with only a sparse occurrence of pines and oaks at The Dalles.

GEOLOGIC RELATIONS OF THE EAGLE CREEK FORMATION

A recent study of the geology of the Columbia River Gorge by Drs. I. A. Williams and J H. Bretz under the auspices of the Oregon Bureau of Mines has given us a rather complete knowledge of the general geology of this little-known region.[1] As far back as 1873 LeConte recorded the presence of fossil leaf impressions in the volcanic conglomerate at the base of the basalt series.[2] In 1895 Diller secured a small collection of leaves near the mouth of Moffatt Creek which has been described by Knowlton,[3] and four years later Gilbert made a larger collection from a talus block near Cascade Locks, a collection which has never been described. The

collections which are the basis of this paper are, however, the first which are sufficiently complete to give any conclusive evidence regarding the age of the Eagle Creek formation.

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Gravels and river terraces of recent origin
Herman Creek lava—andesitic basalt
Satsop formation—stream gravels and volcanic ash
Columbia River lava—successive flows of basalt
Eagle Creek formation—volcanic conglomerate, ash, and tuff

The Eagle Creek formation.—The Eagle Creek formation is exposed along the bottom of the Gorge from Warrendale to Viento on the Oregon side with a corresponding distribution on the north side of the river. It is the oldest formation recognized in the region, and is brought to the surface in the axis of the great north-south anticline which is the backbone of this portion of the range. The thickness of the exposed part of the formation varies from 2,700 feet at Red Bluffs on the Washington side to 500 feet on the Oregon at Bonneville, a condition which appears to be due in part at least to the southward plunge of the fold.

The formation as exposed on Table Mountain and Red Bluffs comprises a series of beds of tuff, ash, and volcanic conglomerate, the conglomerate being most conspicuous near the top. In several of the talus masses of the conglomerate poorly preserved leaf impressions are found, and in both the conglomerate and the tuff silicified wood is common. To the west of Red Bluffs cliffs of conglomerate are conspicuous, and from them have slumped the great masses of rock which have dammed the Columbia River, resulting in its cascades. The base of the formation is reached neither on the Washington nor on the Oregon side.

On the Oregon side the maximum section exposed, 500 feet thick near Bonneville, is a volcanic conglomerate, in most places highly indurated. All the bowlders are of porphyritic basalt, some of them reaching a diameter of 15 feet and averaging from one to three feet in the coarser phases of the formation. The matrix is

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a fine to coarse volcanic sand. Numerous pockets and lenses of shale and sandstone are a characteristic feature. These are of slight extent both vertically and horizontally, and in many cases contain more or less well-preserved leaf impressions. Silicified logs and carbonized stems and fragments are of common occurrence, representing driftwood deposited with the sediments.

The frequence of volcanic activity during the deposition of the sediments is indicated by the seams of volcanic ash which are seen to overlie some of the soil layers representing old surfaces. A quarter of a mile east of Bonneville occurs what is most probably a contemporary extrusion of basalt, and on Greenleaf Creek the sedimentaries are intruded by basalt. In these situations and elsewhere locally the beds have been contorted and shattered, with the development of slickensided surfaces and contact metamorphism.

The upper surface of the Eagle Creek formation, overlain by basalt flows, is markedly irregular, as first noted by LeConte in the canyon of Tanner Creek.[1] Evidences of intraformational unconformities are numerous and will be discussed below.

Collections of fossil plants were made in nineteen localities ranging from the mouth of McCord Creek on the Oregon side of the Gorge to the foot of the cliffs at Red Bluffs in Washington, 7 miles distant. These collections, while made up of rather fragmentary material on the whole, include remarkably well-preserved leaves where the matrix is a fine clay. In most situations the leaves were secured just above a layer of carbonaceous shale which represents the old soil line, in the fine sandy or shaley material laid down upon the old surface.

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[1] J. LeConte, *Am. Jour. Sci.*, 3d Series, VII, 167–80.

THE PLANT-BEARING OUTCROPS

The most important plant-bearing outcrops of the Eagle Creek formation are found between Moffatt and Eagle creeks on the Oregon side of the Gorge, where the building of roads and trails has brought unweathered rock to the surface. The plant localities in this tract are listed in order from west to east. Following thereafter are listed the localities where fossil plants have been secured from slumped material, both in Oregon and in Washington, and a single locality at the extreme western border of the area from which have been secured only grasses and fossil wood.

SECTIONS IN OREGON

MULTNOMAH COUNTY

Locality No. 1.—The outcrop where LeConte first secured leaf impressions, in 1871, and where Diller made collections later, is situated on the south bank of the Columbia River about 100 feet west of the mouth of Moffatt Creek. The leaves are in a dark-colored irregular shaley band a few inches in thickness, and in the coarse sandy bed overlying. Both above and below the leaf-bearing horizon the rock has the coarse conglomerate character which is typical of the formation. LeConte mentions[1] that the dark soil layer was traceable for a mile or more along the river in 1873, but it was not possible to follow it more than a few hundred feet to the west of the mouth of Moffatt Creek at the time of my visit in 1916. Due to the coarse character of the matrix, the plant material is poorly preserved, and is so fragmentary that most of it cannot be identified. Following is the list of the identifiable species secured at this locality:

Acer aquilum
Castanea (?) *radiata*
Quercus pseudo-lyrata

Locality No. 2.—About a quarter of a mile up Moffatt Creek, on the east bank, a leaf-bearing layer is found about 30 feet above the stream. The gray-brown shale containing the leaves is underlain by a dark-colored shaley sandstone, and overlain by the coarse conglomerate phase. The leaf-bearing shale, evidently an old soil line, slopes down from the north at an angle of about 10°. Farther south the talus covering makes it impossible to determine whether the seam slopes up again forming a valley, or whether this slope represents only the side of a hill. The irregularity of the soil line is, however, quite apparent, with a relief of at least 10 feet in the exposed section. The leaf impressions secured are all fragmentary, and include the following species:

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[1] J. LeConte, *Amer. Jour. Sci.*, 3d Series, VII, 167–80.

Acer aquilum
Quercus pseudo-lyrata
Ulmus speciosa

Locality No. 3.—Nearly a mile west of Bonneville, Oregon, in the cut of the O.-W.R.R. & N. is found the following section:

40 feet fine to coarse conglomerate, containing driftwood
2 feet sandstone, coarser at the top, where it grades into the conglomerate
6 inches carbonaceous shale
2 feet coarse sandy shale

Leaf impressions secured at the contact of the carbonaceous shale with the sandstone above include the following species:

Acer aquilum
Laurus similis
Quercus pseudo-lyrata
Ulmus speciosa

Locality No. 4.—A leaf-bearing layer about 300 feet to the west from a point a quarter of a mile west of the Tanner Creek bridge, on the Columbia River Highway. This layer, which is 9 to 18 inches thick, is made up of light-colored sandy shale. Its upper surface, which is about 25 feet above the road where first seen, is gently undulating, and gradually dips toward the west; near its west end it dips sharply with a slope of 16° and passes beneath the road. The section is as follows:

30 feet yellowish conglomerate containing abundant silicified driftwood. Coarse below grading into fine above
9 to 18 inches sandy shale containing large numbers of leaves. Much of this layer is made up of re-worked volcanic dust and cinders
4 to 15 feet fine gravelly sand, locally penetrated by rootlets from above
10 feet coarse conglomerate

Leaf impressions are especially abundant at the top of the abrupt slope described above, where they are densely packed about the stump and roots of a large upright fossil tree. In spite of injury by weathering, the specimens secured here are among the best preserved and most numerous anywhere obtained. Following are the species represented:

Acer aquilum
Acer bolanderi
Acer minutifolia
Betula nanita
Cercis oregonensis
Crataegus pacifica
Cyperacites angustifolia
Carpolithus rugosus
Fraxinus (?) sp.
Ginkgo adiantoides
Hicoria dentata
Hicoria orientalis
Hicoria pecanoides
Laurophyllum oregonensis
Liquidamber acutilobum
Liquidambar europaeum
Liquidambar pachyphyllum
Liriodendron trilobata
Phyllites sp.
Pinus knowltoni
Populus delicatus
Populus Zaddachi
Quercus bretzi
Quercus columbiana
Quercus pseudo-lyrata
Quercus simulata
Rhus bendirei (?)
Salix californica (?)
Ulmus tanneri
Ulmus speciosa

Locality No. 5.—Eight hundred and fifty feet west of the Tanner Creek bridge, on the Columbia River Highway, a bed of cobble conglomerate 20 to 25 feet thick is overlain by a carbonaceous seam several feet in thickness, containing leaves. The general relations are shown by Figure 1. Here bed 1 is a layer of coarse conglomerate which is overlain by bed 2, a seam of carbonaceous sandy shale from 8 inches to 3 feet in thickness. Overlying bed 2 and inclosing the fossil tree which is rooted in the shale is bed 3, comprising 15 feet of sandstone containing numerous bowlders.

The upper surface of bed 1 is suggestive of an erosion surface on which several feet of soil of bed 2 accumulated. The upright tree appears to have been growing in a valley cut in bed 1 during the time of the soil accumulation, and about its roots numerous leaves have been buried and fossilized. The lack of another slope makes the assumption of a valley uncertain, but in any case the sloping soil line establishes the fact that this old land surface had considerable relief at the time bed 3 was deposited on it.

The following species, most of which were secured from about the roots of the stump in bed 2, are recorded:

Acer aquilum
Cercis oregonensis
Hicoria dentata (?)
Laurus similis
Quercus bretzi
Quercus columbiana
Quercus pseudo-lyrata
Scale
Ulmus speciosa

Locality No. 6.—From a point 400 feet west of the Tanner Creek bridge on the Highway a seam of coarse shaley material extends for more than a hundred feet westward. It is carbonaceous, averaging less than a foot in thickness. At scattered points the seam thickens and becomes more sandy, and in several such situations leaf impressions occur. These are fragmental, but the following species have been recognized:

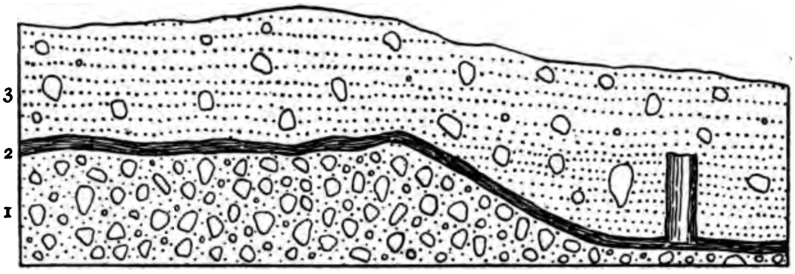

FIG. 1.—Section of the Eagle Creek formation 850 feet west of the Tanner Creek bridge on the Columbia River Highway, showing relations of the soil line and the upright tree.

Acer aquilum
Fagus (?) *bonnevillensis*
Laurus similis
Myrica pacifica
Quercus pseudo-lyrata
Quercus cowlesi
Ulmus speciosa

Locality No. 7.—One hundred and seventy-five feet west of the Tanner Creek bridge a seam of coarse sandy shale 5 to 15 inches thick extends for some 50 feet along the Highway. Below, it is separated from the coarse conglomerate by a few inches of carbonaceous shale. Above, the material is a sandy conglomerate.

The seam contains numerous rootlets and well-preserved leaf impressions of the following species:

Acer aquilum
Liquidambar europaeum
Quercus pseudo-lyrata
Quercus cowlesi
Scale

Locality No. 8.—Fifty feet west of the Tanner Creek bridge an irregular seam of carbonaceous shale hardly more than an inch in thickness is overlain by a layer of yellowish sandy shale containing leaves. This layer varies in thickness from a foot to a foot and a half, the leaves occurring at the thicker points. Above, the pebbly sandstone and conglomerate have a pockety form. The leaves are not well preserved owing to the coarseness of the matrix, but the following species have been recognized:

Laurus similis
Magnolia oregoniana
Myrica pacifica
Nyssa crenata
Phyllites tanneri
Platanus aspera
Quercus simplex
Salix californica (?)

Locality No. 9.—Three-fourths of a mile east of Bonneville, in a cut of the O.-W.R.R. & N., a 6-inch layer of sandy shale contains numerous indistinct impressions of *Acer aquilum.*

Locality No. 10.—A short distance above the half-mile post on the Eagle Creek trail is a pocket of sandy shale 20 feet long and varying in thickness from 6 inches to 2½ feet. The contained leaves are fragmental, due in part to a local crumpling of the beds. The following species were secured here:

Acer aquilum
Cypricites angustifolia
Quercus pseudo-lyrata

Locality No. 11.—About one-eighth of a mile above the half-mile post on the Eagle Creek trail a seam of fine-grained ashy shale was cut into by the trail-makers. It contains large numbers of leaf impressions, which owing to the favorable character of the matrix have been unusually well preserved. Figure 2 shows the relations of the leaf-bearing seam. Here bed 1, a coarse sandstone containing bowlders and silicified driftwood, is overlain by bed 2, the leaf-bearing seam of fine-grained gray shale about 1½ feet in

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Cyperacites angustifolia
Equisetum (?) sp.
Ficus planicostata (?)
Liquidambar pachyphyllum
Oreodaphne litsaeformis (?)
Platanus aspera
Ulmus speciosa

HOOD RIVER COUNTY

Locality No. 16.—About 1,900 feet east of the O.-W.R.R. & N. bridge across Ruckel's Creek a number of rock masses have slumped down to the edge of the Columbia River. It is probable that the leaves contained in some of them have come from several seams, as the matrix of the rocks is different in some specimens from that in others. In any case all have been derived from the Eagle Creek formation, which forms the cliffs above. The following species were secured:

Acer aquilum
Cyperacites angustifolia
Laurus similis
Quercus paucidentata
Quercus pseudo-lyrata
Quercus simplex
Salix californica (?)
Scale
Ulmus speciosa

MULTNOMAH COUNTY

Locality No. 17.—On either side of the McCord Creek bridge along the Columbia River Highway is a seam of fine-grained, highly fractured ashy shale which has a total extent of about 900 feet. It is underlain by a sandy conglomerate in which are rooted the silicified stumps of five trees. The largest of these has a diameter of over 2 feet, and all of them stand upright. No leaves have been found here except those of *Cyperacites angustifolia.*

SECTIONS IN WASHINGTON

Locality No. 18.—At the foot of Red Bluffs, Skamania County, Washington, among the loose fragments which have slumped down from the cliffs of the Eagle Creek formation above, a great conglomerate bowlder was found which was traversed by a 6-inch band of sandy shale containing a few leaf fragments. Among these were recognized the following species:

Acer aquilum (?)
Cyperacites angustifolia
Quercus pseudo-lyrata

Locality No. 19.—In another large mass of sandy conglomerate at the foot of Red Bluffs the following species were secured:

Acer aquilum
Betula heteromorpha
Cyperacites angustifolia
Quercus washingtonia
Quercus pseudo-lyrata
Sabalites sp.

The following table (pp. 126–27) shows the distribution of the species in the Columbia Gorge, the locality numbers corresponding to those given in the preceding pages:

LOCAL DISTRIBUTION OF THE EAGLE CREEK FLORA

	Locality Numbers																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Equisetum (?) sp.											×				×				
Ginkgo adiantoides				×															
Picea (?) sp.											×								
Pinus knowltoni				×							×		×						
Cyperacites angustifolia				×						×	×	×	×	×	×	×	×	×	×
Sabalites sp.																			×
Sabalites (?) sp.											×								
Smilax magna											×								
Phyllites minuta											×								
Populus Zaddachi				×															
Populus delicatus				×															
Salix californica (?)				×				×			×					×			
Myrica pacifica						×		×											
Myrica oregoniana														×					
Hicoria dentata				×	?														
Hicoria orientalis				×															
Hicoria pecanoides				×															
Hicoria williamsi												×							
Juglans ovoides											×								
Alnus oregoniana											×								
Alnus (?) *scabrities*											×								
Betula heteromorpha																			×
Betula nanita				×															
Corylus maxicarpus											×								
Castanea (?) *radiata*	×																		
Fagus (?) *bonnevillensis*						×													
Quercus pseudo-lyrata	×	×	×	×	×	×	×			×	×	×	×	×		×		×	×
Quercus fosteri											×	×							
Quercus merriami											×								
Quercus simplex								×								×			
Quercus simulata				×															
Quercus convexa											×								

Quercus cowlesi						×	×						×						
Quercus washingtonia																			×
Quercus paucidentata																×			
Quercus columbiana				×	×						×		×	×					
Quercus applegatei											×								
Quercus bretzi				×	×														
Quercus sp.											×								
Ulmus speciosa		×	×	×	×	×					×		×	×	×	×			
Ulmus tanneri				×							×		×						
Ficus planicostata (?)															×				
Liriodendron trilobata				×															
Magnolia oregoniana								×			×								
Laurus similis			×		×	×		×								×			
Laurophyllum oregonensis				×															
Oreodaphne litsaeformis (?)															×				
Liquidambar europaeum				×			×												
Liquidambar pachyphyllum				×							×		×	×	×				
Liquidambar californicum											×								
Liquidambar acutilobum				×															
Platanus aspera								×			×				×				
Crataegus heterodentata											×								
Crataegus pacifica				×															
Prunus sp.											×								
Cercis oregonensis				×	×											×			
Leguminosites columbianus											×								
Rhus typhinoides (?)											×								
Rhus bendirei (?)				×															
Acer aquilum	×	×	×	×	×	×	×		×	×	×		×	×	×	×		?	×
Acer completum											×								
Acer bolanderi				×															
Acer minutifolia				×															
Tilia pedunculata											×		×	×					
Nyssa crenata								×					×						
Fraxinus (?) sp.				×															
Phyllites tanneri								×											
Phyllites sp.				×															
Carpolithus bonnevillensis											×								
Carpolithus rugosus				×							×	×							
Scale						×	×				×					×			

THE COMPOSITION OF THE FLORA

The known Eagle Creek flora comprises seventy-two species which fall into thirty-eight genera. These in turn are distributed among twenty-four families and seventeen orders.

The Pteridophyta are represented only by a number of fragments which have been doubtfully referred to the genus *Equisetum*. Knowlton has described a species of Woodwardia[1] collected from the Eagle Creek formation near Cascade Locks, Oregon, by G. K. Gilbert, but although it is abundant in that locality not a trace of it has been found elsewhere in the Gorge. There is no question but that ferns would have been preserved had opportunity offered, for the fine-grained ashy shale of several localities has preserved plant remains much more delicate. In the present forest of the region ferns are a rather conspicuous part of the undergrowth, being both abundant and widespread in habitat. It might be thought that their general absence from the region was due to unfavorable climatic conditions during the Eagle Creek epoch; but the temperature and moisture are shown by various other members of the flora to have been suitable for many if not most of the temperate types of ferns. And even assuming that the climate was too dry for the mesophytic types, it might be expected that Pteris or its ecological equivalent would be present in the woodlands as it is today.

A more plausible explanation of the scarcity of ferns in the Eagle Creek and other Tertiary floras—an explanation which may also apply to the scarcity of the remains of herbaceous forms in these floras—is that due to their low habit they did not readily enter into stream deposits to become buried and fossilized. As will be shown subsequently, the Eagle Creek formation, at least that portion of it containing plant remains, is almost entirely a stream deposit. The leaves preserved in it fell in from trees near at hand, or were blown in from those more distant. Except as ferns or herbs were growing on the immediate edge of the streams which were depositing these sediments, it is difficult to see how their leaves could become incorporated in them, for they could not fall into the streams, and their low position would reduce the chances of their being blown in. It may be noted here that the streams in which these deposits were laid down were swift, as shown by the extremely coarse character of most of the sediments. Along such streams plants other than trees would not be likely to thrive. The scarcity of ferns and herbaceous forms in the Eagle Creek flora may be due then rather to their inaccessibility than to their actual absence. And the local abundance of Woodwardia, which is a swamp-dwelling form, may be the result of the filling up of a stream border marsh and the burial of its flora by the overflowing of a stream during flood.

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[1] "*Woodwardia columbiana*," *Smith. Misc. Coll.*, LII, 491–92.

The Gymnospermae form a very inconspicuous part of the flora, being represented by only three species, one of which is doubtful. Most abundant in range is *Pinus knowltoni*, which is found in three localities, but it is so sparsely represented in each that it cannot be considered to have been at all common. Most abundant in number of individuals is *Ginkgo adiantoides*, of which there are numerous leaf remains in a single locality; clearly it was not a conspicuous member of the forest. The only other representative of this class is *Picea* (?) sp., of which a single cone comprises the sole record.

Knowlton has recognized a species of Cephalotaxus and a Sequoia cone, both undescribed, from the Gilbert collection, but their entire absence in collections from other localities is evidence of their restricted distribution.

The Angiospermae comprise nearly 95 per cent of the flora, and were clearly as dominant during the Eagle Creek epoch as they are today.

Of the subclass Monocotyledonae there are only five species. The Cyperaceae are represented by *Cyperacites angustifolia*, a grass which was both numerous and widely distributed. The Arecaceae were present, as shown by single specimens of two species referred to Sabalites (one doubtfully). That palms were rare is evidenced by the paucity of this record, neither of the specimens being more than fragments, which have not been dignified with specific names, and which are included in this work merely for the sake of completeness.

The only well-defined monocotyledonous species is a member of the Liliaceae, *Smilax magna.* Represented only by a single perfect specimen, this species was distinctly rare so far as may be judged from the record. The leaf is sufficiently large and coriaceous, and is distinctive enough in appearance so that it might be expected to be more commonly included and easily recognized in the collections had the species been common.

Nearly 89 per cent of the flora is included under the Dicotyledonae, and is strikingly similar to the modern flora of the eastern United States. Practically all of the arborescent families are represented, and the similarity is carried to the genera and even to the species in some cases. The table on page 133 shows the number of representatives of the families and genera of the native arborescent forms included in *Gray's Manual* and in the Eagle Creek flora.

Considering the probable incompleteness of the record of the Eagle Creek flora, the ratio of the total number of its species to the total number within the range of *Gray's Manual* is surprisingly great. And if the Rosaceae with eighty-seven species be not included (Sixty-four of these species fall under Crataegus. What paleobotanist would have the temerity to describe sixty-four species of *Crataegus* from a single flora?), there are seen to be one-third as many species in the Eagle Creek formation as in the central and northeastern United States.

It will be further noted that of eight families not represented in the Eagle Creek flora, all but three are of the Metachlamydeae, and that none of these families has more than a feeble representation in the northeastern United States. Further, of twenty-eight genera not represented in the Eagle Creek flora, thirteen are distinctly southern in their range, seven more are most common in the southern states, and only eight are genera characteristic of the northeastern United States. Clearly the Eagle Creek flora, so far as its arborescent dicotyledons are concerned, bears a close similarity to the flora of Ohio, Pennsylvania, and New York.

It is seen that the proportion of species of the more important families in each of the two floras is approximately the same, as in

NUMBER OF SPECIES IN THE ARBORESCENT GENERA AND FAMILIES OF THE NORTHEASTERN UNITED STATES AND THE EAGLE CREEK FLORAS

Families and Genera	Central and Northeastern United States and Canada	Eagle Creek	Families and Genera	Central and Northeastern United States and Canada	Eagle Creek
Salicaceae	30	3	*Pyrus*	7	0
Salix	25	1	*Crataegus*	64	2
Populus	5	2	*Prunus*	12	1
Myricaceae	4	2	Leguminosae	9	2
Myrica	4	2	*Acacia*	1	0
Juglandaceae	10	3	*Gymnocladus*	1	0
Hicoria	8	2	*Gleditsia*	2	0
Juglans	2	1	*Cercis*	1	1
Betulaceae	17	4	*Cladrastis*	1	0
Alnus	5	1	*Robinia*	3	0
Betula	8	2	*Leguminosites*	0	1
Carpinus	1	0	Anacardiaceae	2	2
Corylus	2	1	*Rhus*	2	2
Ostrya	1	0	Aceraceae	6	3
Fagaceae	26	15	*Acer*	6	3
Castanea	2	1	Sapindaceae	4	0
Fagus	1	1	*Sapindus*	1	0
Quercus	23	13	*Aesculis*	3	0
Ulmaceae	8	2	Rhamnaceae	1	0
Ulmus	5	2	*Rhamnus*	1	0
Planera	1	0	Tiliaceae	3	1
Celtis	2	0	*Tilia*	3	1
Moraceae	2	1	Ternstroemiaceae	1	0
Morus	1	0	*Gordonia*	1	0
Ficus	0	1	Araliaceae	1	0
Maclura	1	0	*Aralia*	1	0
Magnoliaceae	6	2	Cornaceae	3	1
Magnolia	5	1	*Cornus*	1	0
Liriodendron	1	1	*Nyssa*	2	1
Lauraceae	4	2	Sapotaceae	1	0
Persea	2	0	*Bumelia*	1	0
Sassafras	1	0	Ebenaceae	1	0
Litsea	1	0	*Diospyros*	1	0
Laurus	0	1	Styracaceae	1	0
Oreodaphne	0	1	*Halesia*	1	0
Hamamelidaceae	2	4	Oleaceae	8	1
Hamamelis	1	0	*Fraxinus*	7	1
Liquidambar	1	4	*Chionanthus*	1	0
Platanaceae	1	1	Bignoniaceae	2	0
Platanus	1	1	*Catalpa*	2	0
Rosaceae	87	3			
Amelanchier	4	0	Total	240	52

the Juglandaceae, Betulaceae, Ulmaceae, and Aceraceae. There is a notable shortage in the Eagle Creek flora of the Salicaceae and Rosaceae, and an excess of the Fagaceae and Hamamelidaceae.

Coming now to a consideration of the individual families, the Salicaceae are represented by two species of *Populus* and a single species of *Salix* doubtfully referred to *Salix californica*. The leaves of *Populus* are not abundant, neither species being found in more than a single locality. They appear to be closely related to modern species of the genus.

The Myricaceae are likewise represented sparsely, there being but two species of which neither is common. One has its modern representative in *Myrica inodora* of the Gulf Coast. The other, originally described by Knowlton from the John Day Basin, appears to be more like *Planera* than *Myrica*. Since the Eagle Creek collections contain only a single fragment, which is unmistakably related to Knowlton's *Myrica oregoniana*, it is not thought best to change the generic reference until more material is available.

The Juglandaceae comprise four species of *Hicoria*, two of which are nuts related to the leaf species, and one of *Juglans*. The *Hicorias* are closely related to common eastern forms; they are not common, being found in but two localities. *Juglans ovoides* is a large form which is common in a single locality.

The Betulaceae are represented by *Alnus*, *Betula*, and *Corylus*, but are inconspicuous in numbers and restricted in range. This is rather surprising in view of the dominance of this family in the deposits of the John Day Basin. The significance of this difference will be further considered in connection with the correlation of the Eagle Creek and John Day deposits.

The Fagaceae comprise the largest part of the flora, being most abundant both in species and individuals. It is of interest to note that a single species of *Quercus*, *Q. pseudo-lyrata*, includes over 60 per cent of the individual specimens in the collections. Its abundance may be due in part to its superior qualities for preservation, as elsewhere discussed, but in any case this species must be considered to have made up a dominant part of the flora. There are altogether thirteen species of *Quercus*, both the round-lobed and pointed-lobed types, as well as those with entire leaves. Considering the abundance of leaf specimens, there is a scarcity of acorns, which may be due to the fact that the oak trees grew at a considerable distance from the sites of deposition, the streams;

for while their leaves might readily be blown for great distances, the chances of wide transportation of the fruit would be much less. The oaks have on the whole a very modern appearance.

The other genera of the Fagaceae, *Castanea* and *Fagus*, are neither of them abundant, being restricted to single localities. *Castanea* is included with doubt, since only the fruits are preserved. However, these are sufficiently characteristic to leave no great question as to the presence in the flora of this genus.

The Ulmaceae are represented by two species of *Ulmus*, both of which are abundant. *Ulmus speciosa*, which has its modern prototype in *Ulmus americana*, is the third most abundant species in the flora, and is found in over half of the localities.

The only representative of the family Moraceae is the single doubtful specimen of *Ficus planicostata*. Clearly this family, which is largely tropical, was not an important part of the flora.

In the Magnoliaceae there is a single species each in the two genera, *Magnolia* and *Liriodendron*. Both of these are restricted in range and numbers of individuals, there being only a single specimen of *Liriodendron* in the collections.

The Lauraceae are more conspicuous, with a single common species of *Laurus*, *Laurus similis*, which is found in several localities, and two other doubtful forms, one of which is referred to *Oreodaphne*, and the other to *Laurophyllum*.

The Hamamelidaceae are well represented by four species of *Liquidambar*. Two of these, *L. europaeum* and *L. pachyphyllum*, are common, and the latter has a wide range. It is possible that the two remaining species, *L. californicum* and *L. acutilobum*, are merely variations of *L. pachyphyllum*, but the former has been considered a distinct species in the flora of the Auriferous Gravels, and neither of the two have intergradations to bridge the gap between them and *L. pachyphyllum*.

There is a single rather common species of *Platanus*, under the Platanaceae. The size, nervation, and margin all indicate its close relation to existing species, notably *Platanus occidentalis*.

The Rosaceae do not make up a conspicuous part of the flora, there being only two species of *Crataegus* and one of *Prunus*. Of the former, *Crataegus heterodentata* is common but is restricted to a single locality, while *Crataegus pacifica* is represented by a single specimen. A single fragmentary specimen of *Prunus* is included without specific determination. All of these species are modern in appearance.

In the Leguminosae there is a single well-defined species, *Cercis oregonensis*, which although represented by numerous specimens is restricted to one locality. It is similar in appearance to the living *C. canadensis*. A fragment of a pod is probably referable to *C. oregonensis*, though possibly it should go with the leaflets of another species described as *Leguminosites columbianus*.

The Anacardiaceae are present, but in meager amount, there being one well-preserved specimen which is referred with doubt to *Rhus typhinoides*, and another which bears a superficial resemblance to *Rhus bendirei*.

The Aceraceae are abundantly represented. There are four species of the genus *Acer*, one of which is a seed species which is no doubt related to the most abundant leaf species, *A. aquilum*. The latter is found in all but three of nineteen localities, and is second in number of individual specimens only to *Quercus pseudo-lyrata*. Due to the large size and delicate character of these leaves, they are seldom found well preserved, but the fragments show the characteristic features of the species. The two small species, *A. bolanderi* and *A. minutifolia*, are distinct from *A. aquilum* and from each other. Specimens of *A. completum*, the seed species, are commonly found, there being more of them than of the much more readily preservable fruits of *Quercus*. This is quite consistent with the suggested reason for the scarcity of acorns, for the trees from which the maple seeds came may be supposed to have grown during the Eagle Creek epoch, as they do today, close to the streams in whose deposits fossilization may occur, and hence to have been in a more favorable position than the oaks to seed these deposits. Altogether the Aceraceae form a conspicuous part of the flora, and there is no question that *Acer* was an important member of the flora.

The Tiliaceae are represented only by the bracts which supported and transported the seeds of a species of *Tilia*, the leaves of which are unknown. These bracts, which have been described as *Tilia pedunculata*, are numerous in several localities, and it is difficult to understand why none of the leaves have been discovered.

Of the Cornaceae there is a single species of *Nyssa*, of which there are numerous well-preserved specimens in two localities. From one locality there is but a single specimen, while from the other some twenty-six specimens were found, all in a single slab of rock. Presumably this localization is due to the restricted habitat of the genus, in swamp borders. No other species of leaves were found in this particular slab, but ten feet away a slab from the same cliff contained numerous leaves of *Quercus pseudo-lyrata* and *Acer aquilum.*

The Oleaceae are doubtfully represented by a well-preserved fragment which may well be *Fraxinus*, although it is too incomplete to make the reference certain.

In the following table the nearest living relatives of the Eagle Creek plants are listed, together with their usual habit or their geographic range. Unless otherwise stated, all of these living species are found in the northeastern part of the United States.

One further phase of the composition of the flora may best be discussed at this point, its ecological composition. In the following table the nearest modern relatives of the species included in the Eagle Creek flora have been listed, together with the characteristic habitats of these living forms. It is not necessary to discuss here the definite relation between the habitat of a given form and its moisture requirements, for this has been an established, though perhaps not fully understood, botanical fact for many years. Nor need we emphasize the existence of this identical relationship as far back into geologic time as rains have fallen and plants have grown. With these two basic ideas, first, of a definite relation between plants and their habitat, controlled largely by their moisture requirements, and second, of the existence of this relation throughout the period of plant life upon the earth, it is clear that a scrutiny of the habitats of the modern representatives of the Eagle Creek plants may throw light upon the conditions for plant growth during the Eagle Creek epoch.

Something more than a resemblance in shape and general appearance is requisite before establishing a relationship between a fossil leaf species and a living form. A comparison of the texture[1] of the one with the other is even more essential in proving an ecological relationship of two forms. This comparison it has been possible to make in many cases, and in the case of each of the critical species. So it is with a great deal of confidence that we can classify the habitats of the modern representatives of the Eagle Creek flora, and carry these habitats back into the Eagle Creek epoch.

By reference to the preceding table, the habitats of the modern forms may be classified as follows, and the species common to them listed. The corresponding Eagle Creek species are in parenthesis.

1. Xerophytic habitat (with little available moisture):

Pinus pungens (*Pinus knowltoni*)
Quercus velutina (*Quercus pseudo-lyrata*)
Quercus heterophylla (*Quercus merriami*)
Quercus reticulata (*Quercus cowlesi*)
Quercus engelmanni (*Quercus washingtonia*)
Quercus prinoides (*Quercus paucidentata*)

2. Mesophytic habitat (with a considerable amount of available moisture):

Ginkgo biloba (*Ginkgo adiantoides*)
Smilax hispida (*Smilax magna*)
Hicoria pecan (*Hicoria pecanoides*)
Juglans nigra (*Juglans ovoides*)
Alnus rhombifolia (*Alnus oregoniana*)
Fagus grandifolia (*Fagus* (?) *bonnevillensis*)
Ulmus americana (*Ulmus speciosa*)
Liriodendron tulipifera (*Liriodendron trilobata*)
Magnolia acuminata (*Magnolia oregoniana*)
Laurus canariensis (*Laurus similis*)
Liquidambar styraciflua (*Liquidambar pachyphyllum*)
Platanus occidentalis (*Platanus aspera*)
Crataegus tomentosa (*Crataegus heterodentata*)
Crataegus spathulata (*Crataegus pacifica*)
Prunus americana (*Prunus* sp.)
Cercis canadensis (*Cercis oregonensis*)
Acer macrophyllum (*Acer aquilum*)
Acer saccharum (*Acer bolanderi*)
Tilia americana (*Tilia pedunculata*)

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[1] Texture determines in large part the moisture-retaining power of a leaf, a thick leaf being better able to retain moisture, and as a result allowing the plant to occupy a drier habitat than a thin-leafed plant.

In addition there may be properly added to this list *Populus balsamifera* (*Populus Zaddachi*), *Myrica inodora* (*Myrica oblonga*), *Quercus bicolor* (*Quercus bretzi*), and *Nyssa sylvatica* (*Nyssa crenata*), all of which may grow on swamp borders, and which are strictly speaking hydro-mesophytes, but whose moisture requirements may be those of the true mesophytes.

3. Xero-mesophytic habitat (moisture intermediate between xerophytic and mesophytic conditions, including plants which have a greater ecological range):

Populus tremuloides (*Populus delicatus*)
Hicoria ovata (*Hicoria dentata*)
Castanea dentata (*Castanea* (?) *radiata*)
Quercus phellos (*Quercus simplex*)
Quercus virginiana (*Quercus convexa*)
Quercus alba (*Quercus columbiana*)

Of thirty-one species classified, six are typical xerophytes, nineteen are typical mesophytes, and six are xero-mesophytes, being intermediate between xerophytes and mesophytes, or overlapping inhabitat. This comes fairly close to being a representative group, for in almost any area in the northeastern part of the United States there will be found several times as many mesophytes as xerophytes. The species omitted from this classification, *Equisetum* (?) sp., *Cyperacites angustifolia*, and *Sabalites* sp., have not been mentioned because the fossils are too incomplete to give any considerable idea as to their ecological requirements.

Since many of the thirty-one species are represented in the collections by single or few individuals, it is clear that all of them do not have equal weight in this classification. But three fossil species are abundant, *Quercus pseudo-lyrata*, *Acer aquilum*, and *Ulmus speciosa*, each of which is represented by hundreds of specimens. Since the living equivalents of these, *Quercus velutina*, *Acer macrophyllum*, and *Ulmus americana*, have well-defined moisture requirements and are typical members of their several habitats, a consideration of the three abundant fossil species and their probable habitats will be most appropriate.

Quercus pseudo-lyrata, the most abundant species in the Eagle Creek flora, is found in fifteen of nineteen localities. Clearly conditions under which it lived may be said to have been widespread. Its leaves have the thickness and coarse epidermis which constitute the morphological expression of a xerophyte. It belongs to a race of oaks whose leaves have pointed lobes and which are largely xerophytic in habitat. The nearest modern relative of *Quercus pseudo-lyrata* is *Quercus velutina*, which is one of the most xerophytic of oaks. It appears entirely probable that *Quercus pseudo-lyrata* occupied a habitat similar to that of *Quercus velutina*, an exposed ridge or upland with a small amount of water. It is appropriate here to mention that the other xerophytes of the flora, one species of *Pinus* and four of *Quercus*, have as their modern equivalents ridge-dwelling species.

Associated with *Quercus pseudo-lyrata*, commonly in the same slab of rock and almost invariably in the same locality, is *Acer aquilum*, a maple closely related to *Acer macrophyllum*, which is an abundant member of the flora now living in the Gorge. Even were it not well known that maples are almost exclusively found in well-watered habitats, the mesophytic character of *Acer aquilum* could be ascertained from the thin texture and large size of the fossil leaves. Occurring in fifteen or sixteen of the nineteen localities furnishing leaves, it is an abundant species, and one which shows moisture requirements widely different from those of *Quercus pseudo-lyrata*. Like its modern relative, we may suppose that it lived on the sides and bottoms of well-watered valleys.

Ulmus speciosa, the third abundant fossil species, had a habitat similar to that of *Acer aquilum*, if the habits of its modern prototype, *Ulmus americana*, are taken as a criterion. And it may be added here that each of the remaining seventeen species listed as mesophytes may likewise be placed in a valley habitat on the basis of the habits of their modern allies. Certain others, as *Populus Zaddachi* (*P. balsamifera*), *Myrica pacifica* (*M. inodora*), *Quercus bretzi* (*Q. bicolor*), and *Nyssa crenata* (*N. sylvatica*), may be considered to have occupied the swampy portions of the valleys.

In summarizing the ecological composition of the flora, we may note that there are two distinct types of plants, the one a xerophytic type, including six species whose modern representatives are dwellers of dry ridges and uplands, the other a mesophytic type, including nineteen species whose modern relatives are dwellers of moist valleys, and four species whose modern relatives live in swamps or swampy valleys. There is a third type made up of seven species whose habitat ranged from xerophytic to mesophytic.

PHYSICAL CONDITIONS

PHYSICAL CONDITIONS INDICATED BY THE LITHOLOGICAL CHARACTER OF THE EAGLE CREEK FORMATION

The Eagle Creek formation is made up entirely of volcanic materials. In the lower part, as exposed at Red Bluffs, beds of tuff and ash are most conspicuous; above, the activity of streams is evidenced by the predominance of conglomerate. Thus it is clear that early in the epoch vulcanism was the dominant process, but that toward the close the streams were able to carry and assort the volcanic material as fast as it was ejected, as well as erode the lava flows bordering the craters. This sedimentary phase is the only one represented on the Oregon side of the Gorge and is the source of practically all of the fossil plants.

There are several conspicuous features, applying especially to the conglomeratic phase, which require analysis. In the first place there is a predominance of coarse material—rounded bowlders ranging up to 15 feet in diameter and averaging from 1 to 3 feet. The textural range is high in any outcrop, large bowlders mingled with small, all bound together by a matrix which varies from coarse gravel to fine mud, but is commonly sandy in texture. The abundance of large bowlders and the almost entire lack of assortment point to the deposition of these sediments by streams which had high velocity.

In the second place the stratification where present is of the lens and pocket type rather than in horizontal layers. This applies to coarse as well as fine materials, but is especially conspicuous in the case of the latter. Nearly all of the sandy and shaley phases occur in the form of lenses or pockets having a horizontal distribution of a few tens of feet and a thickness, with few exceptions, of not more than 15 to 20 feet. This is suggestive of fluctuating conditions of deposition, due either to a variation in the kind of materials available for transportation by the streams, to a variation in the volume of the streams, or to a wandering of the streams over the depositing portions of their courses.

Both of these features suggest that the sedimentation was of the character of a compound alluvial fan, somewhat like that on the flanks of the Sierras.[1] If the Eagle Creek conglomerates were laid down as alluvial fan deposits, it is clear from their thickness that they were deposited on the flanks of a range of considerable height. The evidence of volcanic activity at and near Red Bluffs, on the Washington side of the Gorge, supports the idea that the deposits here were laid down nearer the range than those to the south, on the Oregon side. This evidence includes a basaltic intrusion at Greenleaf Creek and an unusually large amount of pyroclastic material associated with the conglomerate. Further, the paucity of plant remains in the formation near Red Bluffs may suggest the generally unfavorable conditions for plant life in the proximity of active volcanoes. These suggested relations are indicated in Figure 3.

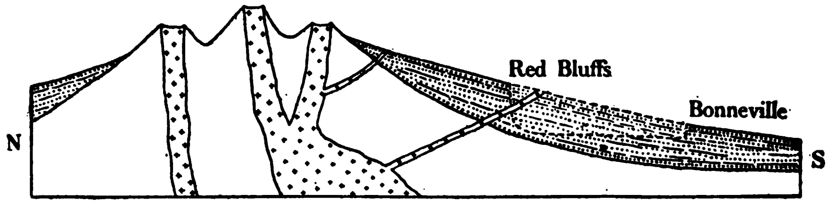

FIG. 3.—Showing the possible relations of the Eagle Creek formation on the flanks of a volcanic peak or range. The dashed line indicates the present position of the Gorge of the Columbia River in cross-section.

In summary, the lithological characters of the Eagle Creek formation—its coarseness, lack of assortment, and lens and pocket stratification—point to the origin of the conglomeratic layers as an alluvial fan deposit on the flanks of a mountain range lying to the north, a range whose volcanoes threw out the great volume of pyroclastic material, and which later were perhaps the sources of the basalt flows.

We may outline the physical history of the Eagle Creek formation as follows: To the north of the Gorge, an east-west range of mountains contained volcanoes which were active throughout the epoch, though probably less active toward its close. Large amounts

[1] A. C. Trowbridge, *Jour. Geol.*, XIX, 707–47.

of ash and tuff were thrown out, with probably some basalt flows, covering the flanks of this range to a depth of more than 2,000 feet. During the intervals of volcanic inactivity, streams assorted the pyroclastic material, producing the beds of volcanic conglomerate. Erosion of the basalt flows by these streams also took place, furnishing the bowlders which characterize the deposits. Toward the close of the epoch streams assumed dominance and transported large amounts of volcanic débris out from the axis of the range, depositing it as far away as the present south side of the Gorge but in progressively lesser amounts. Thin layers of ash in the sections on the south side indicate that a small amount of pyroclastic material was carried there directly from the vents. The dominance of clastic sediments indicates, however, the relatively greater importance of stream deposition here, and the presence of conditions suitable for the development of plant life.

It must not be supposed that the work of the streams was entirely depositional. For in the time between volcanic outbursts, when the bulk of loose material had been transported by the streams, they would commence cutting down into their deposits. As a result there would be developed a topography in which the relief features were due in part to fan deposition and in part to the erosive action of the streams, an alluvial plain sloping toward the south, and cut by rather steep-sided valleys.

PHYSICAL CONDITIONS INDICATED BY THE FLORA OF THE EAGLE CREEK FORMATION

In the consideration of the ecological composition of the flora, the existence in it of two ecological types was brought out. It will now be proper to discuss the significance of this twofold ecological character.

It is of first importance to determine whether these two ecological types represent two distinct habitats from which leaves have become intermingled and fossilized. In modern forests there is a degree of mixture of ecological types, due to the lagging behind of certain relict xerophytes after the plant association has become mesophytic, or to the advance into a xerophytic association of certain pioneer mesophytes. In the first case mentioned, the plants would be dominantly mesophytic with scattered xerophytes, in the second case the plants would be dominantly xerophytic with scattered mesophytes. Neither of these alternatives is applicable to the Eagle Creek flora, in which the abundance of leaves of *Quercus pseudo-lyrata* and other oaks indicates that they represent more than scattered relicts, and in which the abundance of leaves of *Acer aquilum*, *Ulmus speciosa*, and many other species indicates that they represent more than scattered pioneers.

The question may be raised whether the xerophytic species are xeromorphs and owe their structure to a physiologically dry habitat such as a bog. However, the typical xeromorphic leaf is entire-margined, while *Quercus pseudo-lyrata* has conspicuous lobes and sinuses. And even though the supposed xerophytic species were actually xeromorphs, a twofold habitat would still be required, for xeromorphic forms would not be included in the same association with such typical mesophytes as *Acer*, *Ulmus*, and *Platanus*. Clearly the two well-defined ecological types indicate two distinct habitats, one well watered and mesophytic, the other dry and xerophytic.

We may now consider the general type of topography required by the plant evidence. It has been previously noted that the flora is taxonomically similar to the flora of the northeastern United States in a marked degree. In this region today the uplands are commonly occupied by a more or less xerophytic oak association due to the exposure of such a habitat to the sun and wind, and the consequent high rate of evaporation. This condition is especially common in the western part of the region noted above, where the rainfall is between 30 and 40 inches a year. Where such an upland is dissected by valleys, especially by those with rather deep and narrow dimensions, these more protected situations may furnish conditions favorable for the development of a typical mesophytic flora. We may have, then, as a common occurrence, a xerophytic upland association with mesophytic tracts along the streams. Leaves from the upland trees are transported widely, due to exposure to winds, and may be carried down into the valleys and mixed with those of the mesophytes growing there. Such situations are so common today that there is little danger in assuming that they were common during the Eagle Creek epoch, though the geological evidence of such topography should be forthcoming if such were the case. On the basis of the plants, however, it is reasonable to assume the existence of this upland habitat, supporting an oak forest, and occasional valleys occupied by mesophytic maples, elms, and other species.

The mixture of the xerophytic and mesophytic types of leaves may thus be explained on the basis that the former were brought in from above and mixed with the mesophytes in the valley deposits. Aside from the exposed situation of the uplands, which would favor the wide scattering of the leaves which fell upon it, there is the added feature that the thick xerophytic leaves alone would be strong enough to undergo transportation without being destroyed. Surely we must assume that the perfect specimens of maple, sycamore, and other broad thin leaves were not transported far from the spot where they first fell. Further, the large number of mesophytic species associated with the dominant maple and elm leaves indicates that the deposits containing them were laid down in the valleys where they grew. It has been previously pointed out that the scarcity of acorns and the relative abundance of maple seeds is suggestive of the oak trees being at a distance from the streams, and the maple trees near them.

Clearly the flora, with its mesophytic and xerophytic types of plants, is suggestive of a topography of some relief, upland ridges with valleys between, in short, just the sort of topography which is indicated by the lithologic character of the Eagle Creek formation. But however well these ecological requirements are fulfilled by this topography, there should be some actual record of it if it existed during the Eagle Creek epoch. During the first season's work no such evidence was discovered. The requirements of the plants were unsatisfied until a second visit to the Gorge, during which several situations were found where the topography developed during the epoch showed distinct relief. Along the Columbia River Highway cut west of the Tanner Creek bridge, two places were noted where a soil line slopes sharply into a depression. In one of these (see Fig. 1) the soil line slopes down at an angle of 22° and the depression below contains the upright stump of a large tree. Similar situations on Moffatt and Eagle creeks were observed. In the latter the material deposited over the leaf-bearing bed is clearly a valley fill, as shown by the horizontal bedding of the gravelly layers in the sandstone. Further, as previously noted, the upper surface of the formation has marked relief. Clearly the old surfaces within and at the top of the formation show that there were uplands and depressions such as the evidence of the plants demands and such as would have been present in an eroded fan deposit.

There is then a unity of conditions suggested by the ecological character of the plant fossils, the lithological character of the formation, and the relations of the plant-bearing seams in the several sections.

CLIMATE

The similarity of the composition of the Eagle Creek flora to the flora of the northeastern part of the United States has already been pointed out. It is clear that if the Eagle Creek plants had the same climatic requirements as their modern allies, as there is reason to suppose they had, the climate in the Gorge region during the Eagle Creek epoch was not essentially unlike that in the northeastern part of the United States today.

Regarding the temperature factor of the climate of the Eagle Creek epoch, the predominance of temperate families in the flora is significant, especially when it is recalled that there are absent from it most of the families of the northeastern flora which range conspicuously southward. The three genera which are represented by the largest number of individual leaves, and which may be supposed to have dominated the flora, *Quercus*, *Ulmus*, and *Acer*, are all most widely distributed in the temperate regions of the Northern Hemisphere. Of the other genera represented by two or more species in the flora, *Populus* and *Betula* are distinctly northern in range, *Hicoria* and *Crataegus* are confined to temperate regions of the Northern Hemisphere, and *Myrica* and *Liquidambar* are the only ones which commonly range into warm-temperate or subtropical regions. Other genera whose range is into subtropical regions are *Smilax*, *Juglans*, *Ficus*, *Magnolia*, *Laurus*, *Cercis*, and

Nyssa, but since these are represented by single species and none of them are common in the flora, the evidence of the three abundant genera is not outweighed. Rather may we consider these warm-temperate to subtropical forms as relicts of a former forest which had been successfully invaded by a group of temperate forms from the north. The climate of the Gorge area during the Eagle Creek epoch may therefore be supposed to have been but little warmer than the present climate of the northeastern part of the United States, in short not essentially different from that of Oregon and Washington today.

The abundance of xerophytic and xero-mesophytic oaks in the Eagle Creek flora is a feature of primary importance in the consideration of the moisture relations during the Eagle Creek epoch. While common in the northeastern part of the United States today, oaks of the black-oak type are not as dominant a part of the upland forest as we must suppose *Quercus pseudo-lyrata* to have been. In the Gorge region today, oaks (of the round-lobed type) are present on the uplands, but the dominant species is the more mesophytic *Pseudotsuga* (Douglas spruce). The upland plants of any region are the critical part of the flora from a moisture standpoint, since they are most exposed to the drying effects of the sun and wind. We may therefore conclude that the climate during the Eagle Creek epoch was not as moist as it is in the Gorge today. Looking to the mesophytic valley association of the Eagle Creek flora, the presence in it of such moisture-requiring forms as *Acer aquilum*, *Ulmus speciosa*, and many others indicates that in the depressions the air was humid. The moisture was no doubt contributed in large part by the streams occupying the valleys, but the very presence of so mesophytic an association indicates that a climate even approaching aridity did not exist in the region. Rather the moisture conditions were like those at present existing in Illinois and Iowa, where the mesophytes are largely restricted to the valleys. This reduction in amount of rainfall may well have been due to a range of mountains to the west which cut off some of the moisture-bearing winds, though there is no direct evidence for supposing that such a range existed during the Eagle Creek epoch.

THE DURATION OF THE EAGLE CREEK EPOCH AS INDICATED BY THE FOSSIL PLANTS

The flora of the Eagle Creek formation gives valuable suggestions as to the length of time involved in the epoch. From a purely physical standpoint, the great thicknesses of ash, tuff, and conglomerate might have been piled up in a comparatively short time, perhaps measured in scores of years rather than in units of a larger denomination. Turning, however, to the evidence of the plants, it may readily be shown that the time required is much greater. The number of years necessary for the development of a climax forest of a mesophytic sort is estimated to be from one to two hundred years. This is on the basis of there being no soil at the outset, and of its development through the agencies of plants and weathering. It also assumes a soil favorable for the reception of plants. In the case of the soil furnished by the Eagle Creek rocks, there was a distinct time advantage due to the fact that they were not consolidated and therefore offered an immediate foothold for rooted plants. On the other hand the chemical composition of this sediment was probably quite unsuitable for the growth of most higher plants, certainly for the growth of mesophytes. The latter require a humus content which was entirely lacking in the original volcanic materials.

An analysis of unweathered samples of the Eagle Creek shales by John Evanoff, of the University of Iowa chemical laboratories, shows the following composition:

	Per cent
SiO_2	31.00
Al_2O_3	10.04
Fe_2O_3	2.13
CaO	46.20
MgO	7.15
Volatile matter	1.84
Total	98.36

Except for the lack of humus already mentioned, there is no essential lack in this rock from the standpoint of plant nutrition, nor is there any known toxic substance. It has been noted, however, in regions recently covered by volcanic ash that a number of years elapse before the return of the higher plants.

It is not unreasonable therefore to assume that the full one to two hundred years would have been required for the development of a climax mesophytic forest on the volcanic débris-strewn surface during Eagle Creek times.

While it is not possible to correlate the various horizons which contain plant remains in widely separated parts of the area, due to their limited horizontal extent, it is possible to determine, on the basis of relative elevation, that there are at least ten distinct horizons represented. Each of these contains leaves of the climax forest which, as we have seen, would require from one to two centuries for its development. The total length of time involved in the growth of the ten plant horizons may thus be placed at from one to two thousand years. And when it is realized that there must be numerous other plant-bearing horizons which have not been uncovered, the length of the epoch as inferred from plant growth may be greatly extended.

CORRELATION

It is hardly necessary to point out, before attempting to relate the flora of the Eagle Creek formation to the other Tertiary floras of the West, the meagerness of material for comparison. In view of this situation, such correlations as follow may be considered to be tentative pending the large amount of work which must be done on the Pacific Coast before the floras there can be properly interpreted.

Of the seventy-two species included in the Eagle Creek flora, thirty-eight are described as new (two of these have been previously referred incorrectly to other species and are here described under new names), and fourteen are too fragmentary to have any present value for correlation. There remain twenty-two species whose presence has been previously noted in other formations, as shown in the accompanying table.

Ginkgo adiantoides is the only species which is found in rocks older than the Upper Eocene. It is a wide-ranging species, however, being found in the Laramie, Fort Union, and Greenland Eocene; further it is not greatly different from the living *G. biloba,* which may be considered its modern representative. Hence the correlation significance of this species does not have great weight.

Three species, *Populus Zaddachi*, *Quercus convexa*, and *Quercus washingtonia* range from the Upper Eocene to the Miocene, and are therefore of no critical value here.

There remain eighteen species which are restricted in their range to definite horizons. Of these, twelve are confined to the Eocene and six to the Miocene (including the deposits of Table Mountain, California, which are of rather uncertain age). Of the eighteen species twelve are found elsewhere only in the John Day Basin, eight species in the Upper Eocene (Upper Clarno) and four species in the Middle Miocene (Mascall). The Eagle Creek flora is therefore seen to be most closely related to the floras of the John Day region, a relation which might be expected, for the latter is the only considerable flora which has been described from the

Tertiary of the Pacific Coast. However, this close relation may well be real as well as apparent, for the John Day Basin is not far distant from the Columbia Gorge, and the similarity of climate and ease of migration between the two regions would tend to unify their floras.

DISTRIBUTION OF EAGLE CREEK PLANTS IN OTHER FORMATIONS

	Laramie	Fort Union	Upper Eocene (Bridge Creek)	Upper Eocene (?) (Payette)	Upper Eocene (Ashland, Ore.)	Upper Eocene (Chalk Bluffs)	Eocene of Greenland	Middle Miocene (Mascall)	Upper Miocene (Florissant)	Miocene (?) (Table Mountain)
Ginkgo adiantoides	×	×					×			
Populus Zaddachi						×	×		×	
Myrica oregoniana								×		
Betula heteromorpha			×							
Quercus pseudo-lyrata								×		
Quercus merriami								×		
Quercus simplex			×							
Quercus simulata				×						
Quercus convexa						×				×
Quercus washingtonia						×		×		
Quercus paucidentata			×							
Quercus applegatei					×					
Ulmus speciosa			×							
Ulmus tanneri			×							
Ficus planicostata (?)			×							
Laurus similis					×					
Liquidambar europaeum			×							
Liquidambar pachyphyllum								×		
Liquidambar californicum						×				
Platanus aspera			×							
Rhus typhinoides (?)										×
Acer bolanderi										×

RELATION TO THE UPPER CLARNO (BRIDGE CREEK) FLORA

There is the greatest number of species in common between the Eagle Creek flora and that of the Bridge Creek locality of the John Day Basin whose horizon is Upper Eocene. Eight species or about 18 per cent of the latter are found in the Eagle Creek. The most abundant species in number of specimens, ***Betula heteromorpha***, is rare in the Eagle Creek collections, there being but a single imperfect specimen. And the most abundant family, the Betulaceae, which is said by Knowlton to reach its culmination in this horizon, with eleven species, is quite inconspicuous in numbers of specimens in the Eagle Creek flora. There are four of the Bridge Creek species which are found commonly in the Eagle Creek, *Quercus simplex*, *Ulmus speciosa*, *Liquidambar europaeum*, and *Platanus aspera*, and of these *Ulmus speciosa* alone is abundant.

RELATION TO OTHER UPPER EOCENE FLORAS

Of the other floras commonly considered of Upper Eocene age, there is one species, *Quercus simulata*, which is found in the Payette formation of Idaho; there are two species, *Quercus applegatei* and *Laurus similis*, which are found in the beds which may be of this age in the vicinity of Ashland, Oregon; there is one species, *Liquidambar californicum*, which occurs in the deposits at Chalk Bluffs, California (also three others which range up into the Miocene); and there are two species, *Ginkgo adiantoides* and *Populus Zaddachi*, which are found in the Greenland Eocene, and which range down into the Laramie and up into the Miocene respectively. Altogether there are twelve species which are found in the Upper Eocene and in no other horizon.

RELATION TO THE FLORA OF THE MASCALL FORMATION (VAN HORN'S RANCH)

Next to the Bridge Creek flora, the Eagle Creek flora is most closely related in number of common species to the flora of the Mascall formation of Middle Miocene age, at the Van Horn's Ranch locality in the John Day Basin. The most abundant species of the Eagle Creek flora, *Quercus pseudo-lyrata*, is also the most abundant in the Mascall, and *Liquidambar* is common in each. The remaining three species, *Myrica oregoniana*, *Quercus merriami*, and *Quercus washingtonia*, are not common in the Eagle Creek flora. These five species represent only a little over 6 per cent of the whole of the Mascall flora.

RELATION TO OTHER MIOCENE FLORAS

Two species, *Rhus typhinoides* (?) and *Acer bolanderi*, are found in the Table Mountain, California, deposits, and a third, *Quercus convexa*, also is included, though it also ranges down into the Eocene.

A single species, *Populus Zaddachi*, is found in the Florissant beds, but since it ranges down into the Eocene, it has no great importance in this connection.

It will be seen that while most closely related to floras of Upper Eocene age, the Eagle Creek flora is also definitely related to those of Miocene age, if these formations have been correlated correctly. On the basis of these relations it has seemed proper to consider the Eagle Creek flora as transitional between the Upper Eocene and the Miocene, or in other words of Oligocene age. So far as is known to the writer, there is no other flora of the Pacific Coast referred to this age except a small collection from Fossil and Lone Rock in the John Day Basin. The intermediate character of the Eagle Creek flora is borne out by the accompanying table, which shows the horizon of the nearest related species. Here two species are related to those of Lower Eocene age, five to those of Upper Eocene age, one to Oligocene or Miocene, and six to Miocene.

A comparative survey of the composition of the Eagle Creek flora with the Bridge Creek and Van Horn's Ranch floras further bears out its transitional character. As has been pointed out, the Betulaceae which are so important in the Bridge Creek flora are not well represented in the Eagle Creek flora, nor are they numerous in the Mascall. Further the Salicaceae, especially *Salix*, which are abundant in the Mascall flora are barely represented in the Eagle Creek and Bridge Creek floras. In all three the Fagaceae are conspicuous, especially the genus *Quercus*, which includes seven species or 15.5 per cent of the Bridge Creek, seven species or 8.7 per cent of the Mascall, and 13 species or 18 per cent of the Eagle Creek. The Bridge Creek *Quercus* leaves are largely entire and small, while those of the Mascall are mostly lobed and larger. Of the thirteen Eagle Creek species, five are conspicuously lobed, two are conspiciously toothed, and the remainder are either inconspicuously toothed or have entire margins. Clearly the oaks of the Eagle Creek flora are of intermediate type, including survivors of the Bridge Creek and advance types of the Mascall. The abundance of *Quercus pseudo-lyrata*, a Mascall species, in the Eagle Creek flora suggests a close

HORIZONS OF SPECIES RELATED TO EAGLE CREEK PLANTS

	Most Closely Allied Fossil Species	Horizon
Equisetum (?) sp.	*Equisetum oregonense* Newb.	Lower Eocene, John Day
Populus delicatus	*Populus glandulifera* Heer.	Oligocene or Miocene
Salix californica (?)	*Salix californica* Lesq.	Miocene (?), Table Mountain
Myrica pacifica	*Myrica* (?) *idahoensis* Kn.	Upper Eocene (?), Payette
Hicoria dentata	*Hicoria* (?) *oregoniana* Kn.	Lower Eocene, John Day
Juglans ovoides	*Juglans oregoniana* Lesq. and *J. Cryptata* Kn.	Upper Eocene, Chalk Bluffs and John Day
Castanea (?) *radiata*	*Castanea Unger* Heer.	Eocene, Greenland
Quercus cowlesi	*Quercus grönlandica* Heer.	Eocene, Greenland
Crataegus pacifica	*Crataegus imparilis* Kn. and *Crataegus flavescens* Newb.	Middle Miocene, John Day Upper Eocene, John Day
Prunus sp.	*Prunus* (?) *merriami* Kn. and *Prunus* (?) *tufacea* Kn.	Middle Miocene, John Day
Cercis oregonensis	*Cercis parvifolia* Lesq.	Upper Miocene, Florissant
Rhus bendirei (?)	*Rhus bendirei* Lesq.	Middle Miocene, John Day
Acer aquilum	*Acer bendirei* Lesq.	Middle Miocene, John Day

relation to the Mascall, but this relation may be homotaxial rather than synchronous. For if a group of northern oaks, represented by *Q. pseudo-lyrata*, were migrating down into Oregon, as a result of a general cooling in climate, they would be likely to reach the Columbia Gorge before the John Day Basin, or at least there is a possibility of unequal distribution in the invading group.

The Eagle Creek flora is therefore considered to be of Oligocene age on the basis of the species common to the Upper Eocene below and the Miocene above, and on the basis of the intermediate character of the flora from the standpoint of its composition.

SYSTEMATIC DESCRIPTIONS

Phylum PTERIDOPHYTA

Order EQUISETALES

Family EQUISETACEAE

EQUISETUM (?) sp.

Description.—Stems cylindrical, with distinct vertical ridges and grooves. Diameter from 6 to 16 mm. All of the specimens are fragmentary, and in lack of any showing the node, they are referred to this genus with doubt.

Occurrence.—Multnomah County, Ore., Localities Nos. 11 and 15.

Collection.—Walker Museum, University of Chicago.

Phylum SPERMATOPHYTA

Class GYMNOSPERMAE

Order GINKGOALES

Family GINKGOACEAE

GINKGO ADIANTOIDES Unger

Plate V, Figure 1

Ginkgo adiantoides, Heer, *Flora Fossilis Arctica*, VI, 21, Pl. II, Figs. 7–10.
Ginkgo adiantoides, Ward, *U.S.G.S. Bull. 37*, p. 15, Pl. I, Figs. 5, 6.

Among the numerous specimens from Locality No. 4, there is a considerable variation in shape, especially in the attenuation of the base, where it attaches to the petiole. The margin of all is undulate, without any suggestion of bilobation. Length 3 to 3.5 cm., width 4.5 to 5 cm.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

Order CONIFERALES

Family PINACEAE

PICEA (?) sp.

Plate V, Figure 2

Description.—Cone ovate-cylindrical. Scales broadly rounded above, closely appressed, 1 mm. high and 1.5 mm. broad. Length of cone 3.5 cm., width 1.3 cm.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

PINUS KNOWLTONI Chaney, n.sp.

Plate V, Figures 3 and 4

Description.—Needles in bundles of three, flattened, and with a distinct mesial ridge, appearing to come to a sharp point terminally. Length exceeding 6 cm., breadth 1 mm. All of the material is fragmentary.

Associated with the needles in Locality No. 11 are numerous cones. Of these several appear to be staminate, a central stalk 1.5 cm. long bearing slender sporophylls 4 mm. long and with turned-down ends. A single ovulate cone in radial section is made up of a central stalk with sporophylls 1 cm. long, bearing oval-acuminate seeds.

I take great pleasure in naming this species in honor of Dr. F. H. Knowlton, whose assistance has been of extremely great value in working over this flora.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 11, and 13.

Collection.—Walker Museum, University of Chicago.

Class ANGIOSPERMAE

Subclass MONOCOTYLEDONAE

Order GRAMINALES

Family CYPERACEAE

CYPERACITES ANGUSTIFOLIA Chaney, n.sp.

Plate VI, Figure 2

Description.—Blades long and slender, with bluntly rounded or pointed tips. A distinct line running down the center, forming a shallow depression on the one side, and a ridge on the other side, of the blade. Length exceeding 10 cm., breadth up to 3 mm.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 10, 11, 12, 13, 14, 15, and 17; Hood River County, Ore., Locality No. 16; Skamania County, Wash., Localities Nos. 18 and 19.

Collection.—Walker Museum, University of Chicago.

Order ARECALES

Family ARECACEAE

SABALITES sp.

Plate V, Figure 5

Description.—The material is fragmentary and poorly preserved, representing a leaf at least 30 cm. in width, made up of convex rays about 1 cm. in width, with furrows 2 mm. deep between them. The rays have numerous indistinct parallel nerves.

Occurrence.—Skamania County, Wash., Locality No. 19.

Collection.—Walker Museum, University of Chicago.

SABALITES (?) sp.

A fragment of the ray of a leaf is carinate, with numerous parallel veins. The ray is 2.1 cm. across.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Order LILIALES

Family LILIACEAE

SMILAX MAGNA Chaney, n.sp.

Plate VI, Figure 1

Description.—Leaf asymmetrically cordate at the base, tapering gradually to a blunt point. Margin entire, slightly undulate. Texture coriaceous. Nervation palmate, a prominent central nerve and three pairs of lateral nerves; of the latter, the inner pair curve up nearly parallel with the central nerve and are distinct nearly to the tip of the leaf; of the middle pair one reaches nearly to the tip, while the other branches out and loses its identity less than halfway up; the outer pair are short, curving out roughly parallel to the cordate margin, and losing their identity in the basal part of the leaf; the secondaries are numerous, forming a coarse network with the tertiary nerves. The single specimen is nearly 11 cm. long, and varies in width from 6 cm. near the base to less than 2 cm. at the tip.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

MONOCOTYLEDONAE INCERTAE SEDIS

PHYLLITES MINUTA Chaney, n.sp.

Plate VI, Figures 3 and 4

Description.—Leaves small, elliptical, rounded at both ends. Margin entire, slightly recurved. Nervation distinct, five parallel veins arising at the base and terminating in the apex; petiole slender elongate, curved. Length 7 to 9 mm., width 2.5 to 3 mm. Length of petiole 3 mm.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Subclass DICOTYLEDONAE

Order SALICALES

Family SALICACEAE

POPULUS ZADDACHI Heer

Plate VII, Figures 1 and 2

Populus Zaddachi, Heer, *Flora Tertiaria Helvetiae*, III, 307.

Populus Zaddachi, Heer, *Flora Fossilis Arctica*, I, 98, Pl. 6, Figs. 1–4; Pl. 15, Fig. 1b; II, 468, Pl. XLIII, Fig. 15a; Pl. XLIV, Fig. 6.

Populus Zaddachi, Lesquereux, *Ann. Rept. U.S. Geol. and Geog. Surv. Terr.*, p. 292.
Populus Zaddachi, Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, 11, Pl. 8, Figs. 1–8.
Populus Zaddachi, Lesquereux, *Cretaceous and Tertiary Flora*, p. 158, Pl. XXXI, Fig. 8.

It is with some hesitancy that the Eagle Creek material is referred to this species. From the original species as described by Heer, it differs in the more elongate shape of the leaves, the finer dentation of their margins, and the inconspicuous development or lack of glands in the teeth. In view of the close similarity of these specimens to those figured by Lesquereux as *Populus Zaddachi*, they are referred to this species and figured, with the hope that the relations of our American forms to those of Greenland may later be more fully worked out. The Eagle Creek collections contain several well-preserved specimens.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

POPULUS DELICATUS Chaney, n.sp.

Plate VII, Figures 3 and 4

Description.—Leaves broadly ovate, with gradually narrowing apex, and base slightly cordate. Margin poorly preserved, but apparently coarsely dentate. Palmately five-nerved, the lower lateral nerves extending horizontally, parallel with the margin; the upper lateral nerves curve out, paralleling the margin in the upper third of the leaf, and losing their identity through connections with the secondaries of the central nerve; central nerve with several pairs of strong secondaries which curve out parallel with the upper lateral nerves and merge into them at the margin near the apex; numerous smaller secondaries leave the main nerves at approximately right angles and form a distinct and roughly rectangular network with the nervilles. Length about 3 cm., width 2.7 cm.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

SALIX CALIFORNICA Lesquereux (?)

Salix californica, Lesquereux, *Mem. Mus. Comp. Zoöl.*, Vol. VI, No. 2, p. 10, Pl. I, Figs. 18–20.

Several incomplete specimens resemble this more closely than any other species. From the character of the material, however, its reference to *Salix californica* is doubtfully made.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 8, and 11; Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

Order MYRICALES

Family MYRICACEAE

MYRICA PACIFICA Chaney, n.sp.

Plate VII, Figure 5

Description.—Leaves oblong-obovate, rounded to a blunt point at the apex, base broad, wedge-shaped. Margin distinctly serrate except at the base, the teeth blunt, triangular. Midrib very strong; secondaries branching off at an angle of 60°, camptodrome. Length 4 to 7 cm., width 1.5 to 2.2 cm.

Only two specimens of this species are included in the collections.

Occurrence.—Multnomah County, Ore., Localities Nos. 6 and 8.

Collection.—Walker Museum, University of Chicago.

MYRICA OREGONIANA Knowlton

Myrica oregoniana, Knowlton, *U.S.G.S. Bull. 204*, p. 33, Pl. III, Fig. 4.

A single incomplete specimen is identical with this John Day species. I eel some hesitation in leaving it under the genus *Myrica*, for its ovate shape and its margin more strongly suggest *Planera*. Lacking more complete material, however, it is not possible to decide with any certainty to which genus it rightfully belongs.

Occurrence.—Multnomah County, Ore., Locality No. 14.

Collection.—Walker Museum, University of Chicago.

Order JUGLANDALES

Family JUGLANDACEAE

HICORIA DENTATA Chaney, n.sp.

Plate VIII, Figure 1

Description.—Leaflet ovate-lanceolate, with an acuminate apex, base not preserved. Margin coarsely serrate, the teeth triangular, rounded or pointed, and directed outward. Midrib slender; secondaries branching off at an angle of from 55° to 75°, curving upward near the margin, and branching irregularly, the branches uniting and terminating in the teeth; tertiaries distinct, with the nervilles forming a fine network. Length about 10 cm., width 5.5 cm.

Although represented by a single incomplete specimen, this species is distinct from other members of the genus in the large, usually rounded, and outward-pointing teeth.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

HICORIA ORIENTALIS Chaney, n.sp.

Plate VIII, Figure 2

Description.—Nut ovoid-pyriform, with a rounded base and a bluntly acuminate apex. Divided into two equal valves by major ridges which are bordered laterally by two smaller ridges, giving a six-ribbed shell, with minor rugosities. Somewhat appressed along a plane at right angles to the valve ridges. Length 2.7 cm., diameter 2.1 cm.

In all probability this is the nut of *Hicoria dentata*, as both the nut and the leaflet are found in the same locality.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

HICORIA PECANOIDES Chaney, n.sp.

Plate VIII, Figure 3

Description.—Leaflet obovate-lanceolate, apex incomplete but apparently acuminate; gradually narrowing to an unequally wedge-shaped base. Margin broadly undulate, serrate except at the base, the teeth pointing upward or slightly recurved, unequal. Primary nerve strong; about twenty-two pairs of secondaries leaving the midrib at angles varying from 75° near the base to 40° at the apex, curving gradually upward and becoming camptodrome near the margin; nervilles indistinct. Length 10.8 cm., width 3.3 cm.

The single specimen is excellently preserved, and closely resembles the leaf of *Hicoria pecan*, differing from it only in its obovate shape. The presence in a collection from another locality of a nut unmistakably related to *Hicoria pecan* lends support to the reference of this species to a pecan-like *Hicoria.*

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

HICORIA WILLIAMSI Chaney, n.sp.

Plate VIII, Figure 4

Description.—Nut oblong-ovate, acute at the ends, with the base rounded and the apex more pointed; obscurely four-ribbed, and with numerous indistinct branching furrows. Length 3 cm., diameter 1.8 cm.

This species is named in honor of Professor I. A. Williams, by whom it was collected. It is in all probability the fruit of *Hicoria pecanoides.*

Occurrence.—Multnomah County, Ore., Locality No. 12.

Collection.—Walker Museum, University of Chicago.

JUGLANS OVOIDES Chaney, n.sp.

Plate IX, Figures 1 and 2

Description.—Leaflets oblong-ovate; base asymmetrical with an acute point on one side, rounded acuminate on the other; tip imperfectly preserved, probably bluntly acuminate. Secondary nerves leaving the midrib at an angle of about 90°, gradually curving upward, and forking toward the margin. Margin coarsely serrate, the teeth sharp pointed, directed upward and outward. Length about 11 cm., width about 5 cm. The specimens are all incomplete, but show all of the characteristics of the leaflets except the apex.

This species has the general form and nervation of *Juglans oregoniana*[1] and *J. hesperia*,[2] but differs from them in its more coarsely dentate margin and its acuminate base. A leaf in an undescribed collection in the U.S. National Museum, secured in the Columbia Gorge by G. K. Gilbert, is probably referable to this species.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Order FAGALES

Family BETULACEAE

ALNUS OREGONIANA Chaney, n.sp.

Plate X, Figures 1 and 2

Description.—Leaves ovate, tapering to a blunt point at the apex, the base broadly rounded, abruptly cuneate at the point of attachment to the petiole. Margin poorly preserved, apparently simply and rather coarsely dentate. Petiole slender, curved, 5 mm. long. Midrib very stout; secondaries well developed, six pairs branching out alternately at angles of 30° to 50°, curving regularly upward, commonly with several camptodrome branches from the lower side; the lowest pair of secondaries branching off at the base of the leaf; finer nervation conspicuously developed. Length 4.5 to 5.5 cm., width 4 cm.

Two examples of this species were secured, both on the same slab. The proportions of the two vary, the longer leaf being narrower than the shorter.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

ALNUS (?) SCABRITIES Chaney, sp.

Description.—Staminate ament elongate-paniculate, each staminate flower inclosed in large scalelike bracts which give the ament a rough appearance; relations of the flowers and bracts not clear due to imperfect preservation. Stem short and stout. Length of ament 3.5 cm., diameter 7 mm.

The general resemblance of the single specimen to the aments of *Alnus* has led to its doubtful reference to this genus.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

BETULA HETEROMORPHA Knowlton

Betula heteromorpha, Knowlton, *U.S.G.S. Bull. 204*, p. 39, Pl. III, Fig. 5.

There is a single incomplete specimen which appears to be identical with this abundant John Day species. Its rarity in the Eagle Creek collections is a fact of considerable interest.

Occurrence.—Skamania County, Wash., Locality No. 19.

Collection.—Walker Museum, University of Chicago.

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[1] Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, Pl. 9, Fig. 10.

[2] Knowlton, *18th Ann. Rept. U.S. Geol. Surv.*, p. 723, Pl. 99, Fig. 8.

BETULA sp.

Description.—A small fragment of the distal portion of a leaf is referred to this genus because of its resemblance to *Betula alba*.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

BETULA NANITA Chaney, n.sp.

Plate IX, Figure 3

Description.—Leaf oblong-ovate, narrowing gradually to a broad apex and more abruptly to an acute base. Margin slightly crenulate, deeply serrate at the apex, the teeth pointing upward and slightly outward. Secondaries leaving the midrib at an angle of 20° and terminating in the teeth. Length 1.5 cm., width 7 mm.

This species is described on the basis of a single complete, though rather obscurely preserved, specimen.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

CORYLUS MAXICARPUS Chaney, n.sp.

Plate IX, Figure 4

Description.—Nut smooth, spheroidal, with a large attachment scar with radiating laminae. Length 1.5 cm., diameter 1.9 cm.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Family FAGACEAE

CASTANEA (?) RADIATA Chaney, n.sp.

Plate X, Figures 3, 4, and 5

Description.—Fruit three- to four-valved, the valves ovate-oblong, with an acuminate tip and a strong mesial furrow, covered with slender radiating spines. Nuts obscurely preserved, possibly three to an involucre. In all specimens the valves have opened. Length of fruit 1.8 cm., diameter 1.2 cm., length of spines up to 8 mm.

This may be compared to the fruit of *Castanea* Unger described by Heer.[1] It bears a superficial resemblance to *Carpolithes spinosus* Newberry.[2] A considerable number of specimens have been secured from a single pocket.

Occurrence.—Multnomah County, Ore., Locality No. 1.

Collection.—Walker Museum, University of Chicago.

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[1] Heer, *Flora Fossilis Arctica*, II, 470, Pl. XLV, Figs. 2, 2b.

[2] Newberry, *U.S.G.S. Mon. 35*, Pl. LXVIII, Figs. 2–3.

FAGUS (?) BONNEVILLENSIS Chaney, n.sp.

Plate XI, Figure 1

Description.—Leaf oblong-ovate, with a broadly wedge-shaped base, apex incomplete. Margin serrate, with spreading triangular teeth. Midrib curving, stout basally and diminishing toward the apex; petiole stout, over a centimeter in length; secondaries branching off regularly at an angle of about 40°, and curving upward, craspedodrome; tertiaries short, numerous, branching off at right angles and joining across the intersecondary spaces by arched extensions. Length 9.5 cm., width 6 cm. Because of its fragmentary character the single specimen is referred doubtfully to the genus *Fagus*.

Occurrence.—Multnomah County, Ore., Locality No. 6.

Collection.—Walker Museum, University of Chicago.

QUERCUS PSEUDO-LYRATA Lesquereux

Quercus pseudo-lyrata, Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, 8, Pl. II, Figs. 1–2.
Quercus pseudo-lyrata, Lesquereux, *Proc. U.S. Nat. Mus.*, XI, 17, Pl. X, Figs. 1–3; Pl. XI, Fig. 1; Pl. XII.
Quercus pseudo-lyrata, Knowlton, *U.S.G.S. Bull. 204*, p. 48.

This species is the dominant one of the flora, being represented by over one thousand six hundred specimens secured from fifteen out of the eighteen localities furnishing leaves. The name is an unfortunate one, suggesting as it does a close resemblance to the living *Quercus lyrata*, which has rounded lobes. *Quercus pseudo-lyrata* resembles *Q. velutina*, *Q. californica*, and *Q. georgiana*, not only in general appearance, but in texture, being subcoriaceous. Specimens range in size from 6 to 17 cm., averaging about 10 cm. Leaf galls are present on a number of specimens.

Occurrence.—Multnomah County, Ore., Localities Nos. 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, and 14; Hood River County, Ore., Locality No. 16; Skamania County, Wash., Localities Nos. 18 and 19.

Collection.—Walker Museum, University of Chicago.

QUERCUS FOSTERI Chaney, n.sp.

Plate XI, Figures 2 and 3

Description.—Nut ovate-acuminate, 1.4 cm. in diameter near the base, diminishing to 3 mm. at the tip, which is farther prolonged into a short blunt point. Length 1.8 cm. Associated cup shallow, 6 mm. deep and 16 mm. in diameter, made up of large appressed scales; stem short and stout. Small specimens, probably immature or abortive, have the cup almost completely inclosing the nut.

Acorns are fairly numerous, all resembling in a general way the specimens described. It is probable that most of these should be associated with the most abundant leaf species, *Quercus pseudo-lyrata*.

Occurrence.—Multnomah County, Ore., Localities Nos. 11 and 12.

Collection.—Walker Museum, University of Chicago.

QUERCUS MERRIAMI Knowlton

Quercus pseudo-lyrata angustiloba, Lesquereux, *Proc. U.S. Nat. Mus.*, XI, 17, Pl. XI, Fig. 2.

Quercus merriami, Knowlton, *U.S.G.S. Bull. 204*, p. 49, Pl. VI, Figs. 6–7; Pl. VII, Figs. 4–5.

Several typical examples of this slender species are included in the collections. The absence of forms intermediate between this and *Quercus pseudo-lyrata* makes more certain the correctness of Knowlton's separation of these into two distinct species.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

QUERCUS SIMPLEX Newberry

Plate XI, Figure 4

Quercus simplex, Newberry, *Proc. U.S. Nat. Mus.*, V, 505.

Quercus simplex, Newberry, *U.S.G.S. Mon. 35*, p. 78, Pl. XLIII, Fig. 6.

Quercus simplex, Knowlton, *U.S.G.S. Bull. 204*, p. 44.

There are numerous specimens of small coriaceous oak leaves, of which several, including the one figured, closely resemble *Quercus simplex* as described by Newberry. There appears to be a gradation in length up to 7 to 8 cm., and in shape to more broadly lanceolate than the typical *Q. simplex* as previously described. Whether these forms should be included under this species is somewhat doubtful, though they resemble it more closely than they do *Q. simulata* or *Q. convexa*. Surely it is desirable to assemble the types of the above-mentioned species and others of a similar sort from the Western Tertiary with a view toward determining such specific delimitations or intergradations as may exist.

Occurrence.—Multnomah County, Ore., Locality No. 8; Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

QUERCUS SIMULATA Knowlton

Plate XII, Figure 1

Quercus simulata, Knowlton, *18th Ann. Rept. U.S. Geol. Surv.*, Part III, p. 728, Pl. 101, Figs. 3–4; Pl. 102, Figs. 1–2.

Two specimens resemble this species closely in shape and margin, although the nervation is too obscure to be clearly made out. They differ from *Q. consimilis* in the rounded character of the apex and the less distinct and rounded teeth.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

QUERCUS CONVEXA Lesquereux

Quercus convexa, Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, 43, Pl. I, Figs. 13–17.

Quercus convexa, Lesquereux, *Cretaceous and Tertiary Flora*, p. 265, Pl. XLV B, Figs. 5–6.

Several fragmentary specimens appear to be referable to this species.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

QUERCUS COWLESI Chaney, n.sp.

Plate XI, Figure 5

Description.—Leaves ovate to obovate, obtusely rounded at the apex, base incomplete, probably rounded. Margin repandly spinose-dentate. Secondary nerves leaving the midrib regularly, at an angle of about 60°, curving upward slightly near the margin, craspedodrome; nervilles dividing the intersecondary spaces into rectangles, branching to form a fine network near the margin. Length 9 to 14 cm., width 5.5 to 6.6 cm.

These leaves resemble those figured by Heer as *Quercus grönlandica* in his *Flora Fossilis Arctica*, I, Pl. X, Figs. 3–4; Pl. XLVII, Fig. 1; II, Pl. XLV, Fig. 4.

Occurrence.—Multnomah County, Ore., Localities Nos. 6, 7, and 13.

Collection.—Walker Museum, University of Chicago.

QUERCUS WASHINGTONIA Chaney, n.sp.

Plate XII, Figures 2 and 3

Quercus horniana, Lesquereux, *Proc. U.S. Nat. Mus.*, XI, 17, Pl. V, Fig. 6.

Ulmus californica, Lesquereux, *Cretaceous and Tertiary Flora*, p. 265, Pl. XLV B, Figs. 3, 4, and 7.

Description.—Leaves coriaceous, ovate-ellipsoid, wedge-shaped to subcordate at the base, tips incomplete but apparently rounded. Margin crenately serrate, the lower teeth rounded, the upper bluntly pointed. Primary vein stout; secondaries slender, branching off at an angle of 50° and curving gradually upward to terminate in the teeth. Length 4.2 to 6.5 cm. (estimated), width 1.8 cm.

This species appears to be identical with those figured by Lesquereux as *Quercus horniana*, and later as *Ulmus californica*. The former reference is clearly an error; regarding the latter, Knowlton[1] expresses doubt as to their being identical with *Ulmus californica*. Surely they differ, both in the case of the specimens figured by Lesquereux and those here described, from the type figures of the species in Lesquereux' treatise on the *Flora of the Auriferous Gravels*,[2] in which the leaf margins are compoundly dentate. It has therefore been thought desirable to name this as a new species, referred to the genus *Quercus* on the basis of its resemblance to several species of living oaks of the live-oak type.

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[1] *U.S.G.S. Bull. 204*, p. 55.

[2] *Mem. Mus. Comp. Zoöl.*, VI, 15, Pl. IV, Figs. 1, 2; Pl. VI, Fig. 7*a*.

Occurrence.—Skamania County, Wash., Locality No. 19.

Collection.—Walker Museum, University of Chicago.

QUERCUS PAUCIDENTATA Newberry

Quercus paucidentata, Newberry, *Proc. U.S. Nat. Mus.*, V, 505.
Quercus paucidentata, Newberry, *U.S.G.S. Mon. 35*, p. 76, Pl. XLIII, Fig. 1.

Two specimens are identical with this species, having the margin entire below and broadly dentate above, and with an acuminate tip. Length 9 to 11 cm., width 3.5 to 4 cm.

They bear a strong resemblance to *Quercus furcinervis* as described by Lesquereux in his *Cretaceous and Tertiary Floras* (p. 244, Pl. 53, Figs. 10–12), which species has been transferred by Knowlton[1] to *Quercus affinis*.

All three species involved come from the John Day Basin, and part of Lesquereux' material was secured by LeConte in the Cascade Mountains of Oregon, almost certainly from the Eagle Creek formation in the Gorge. I prefer the reference of my Eagle Creek specimens to *Q. paucidentata* as described by Newberry, because of the entire character of the basal portions of the leaves.

Occurrence.—Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

QUERCUS COLUMBIANA Chaney, n.sp.

Plate XIII, Figures 1 and 2

Description.—Leaves oval to oblong-obovate, gradually narrowed to a broadly wedge-shaped or rounded base, apex broad, with a rounded terminal lobe and two rounded lateral lobes; divided into about six pairs of entire lobes which are broad and mucronate at the base, broadly to narrowly rounded above; sinuses mostly broad triangular, those near the apex being more narrowly triangular. Midrib strong, with a stout petiole over a centimeter in length; secondaries branching off at angles varying from 35° to 65°, the lower angles toward the tips, and throughout the leaf in certain specimens, as that shown in Figure 2, Plate XIII; tertiaries distinct, leaving the secondaries at approximately right angles, camptodrome. Length from 7 to 15 cm., averaging 10 cm., width 3 to 6 cm., averaging 5 cm.

There is considerable difference in the shape of the lobes and the angles of the secondary nerves in the various specimens, as is shown in Figures 1 and 2, Plate XIII. Since there is a gradation between these two types, it appears that they represent merely variations of a single species.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 5, 11, 13, and 14.

Collection.—Walker Museum, University of Chicago.

[1] *U.S.G.S. Bull. 204*, p. 45.

QUERCUS APPLEGATEI Knowlton

Quercus applegatei, Knowlton, *20th Ann. Rept. U.S. Geol. Surv.*, p. 42, Pl. I, Figs. 6, 7.

A single specimen of this small oak appears to be identical with the species named by Knowlton from near Ashland, Ore.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

QUERCUS BRETZI Chaney, n.sp.

Plate XII, Figure 4, and Plate XIII, Figure 3

Description.—Leaves obovate, with base unequally and narrowly cordate, apex broad-crenulate, three-lobed; divided by broad shallow-rounded sinuses into six to seven obtusely rounded lobes. Midrib stout, with a long slender petiole; secondaries branching off at an angle of about 65°, curving outward, or outward and upward to terminate in the lobes; nervilles forming a fine network. Length 10 to 20 (estimated) cm., width 7.5 to 12.5 (estimated) cm.

I take pleasure in naming this species in honor of Dr. J H. Bretz, whose discovery of the first considerable leaf-bearing deposit on Eagle Creek directed my attention to this fruitful locality.

Occurrence.—Multnomah County, Ore., Localities Nos. 4 and 5.

Collection.—Walker Museum, University of Chicago.

QUERCUS sp.

Plate XIII, Figure 4

Description.—Leaves coriaceous, ovate, with base unequally wedge-shaped and twisted, tip of leaves missing. Margin finely serrate, the teeth acute and variously directed. Secondaries curving upward, camptodrome.

The material is too fragmentary to warrant a specific name.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Order URTICALES

Family ULMACEAE

ULMUS SPECIOSA Newberry

Ulmus speciosa, Newberry, *Proc. U.S. Nat. Mus.*, V, 507.

Ulmus pseudo-americana, Lesquereux, *Cretaceous and Tertiary Flora*, p. 249, Pl. LIV, Fig. 10.

Ulmus speciosa, Newberry, *U.S.G.S. Mon. 35*, p. 80, Pl. XLV, Figs. 2–4, 7.

Ulmus speciosa, Knowlton, *U.S.G.S. Bull. 204*, p. 53.

Typical leaves of this species are abundantly represented, being exceeded in number only by *Quercus pseudo-lyrata* and *Acer aquilum*. Associated with this large form are numerous leaves of *Ulmus*, differing from it in their smaller size and their ovate rather than lanceolate shape. Since there is no intergradation from the one to the other, it appears that they may best be considered as two distinct species. The smaller form is therefore designated as *Ulmus tanneri.*

Occurrence.—Multnomah County, Ore., Localities Nos. 2, 3, 4, 5, 6, 11, 13, 14, and 15; Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

ULMUS TANNERI Chaney, n.sp.

Plate XIV, Figures 1 and 2

Ulmus speciosa, Newberry, *U.S.G.S. Mon. 35,* p. 80, Pl. XLV, Figs. 5 and 8.

Description.—Leaves ovate-oblong, gradually narrowing at the apex into a blunt point, full and rounded at the base on one side, shorter and only slightly rounded on the other. Margin coarsely and compoundly serrate, commonly with two smaller teeth in association with and below each of the main teeth, which point outward and upward. Midrib stout, with a short petiole; about seventeen pairs of secondaries branching off alternately at an angle of 40°, commonly forking toward the margin and terminating in the main teeth; nervilles forming a close network. Length 5 to 6.5 cm., width 2.7 to 3.2 cm.

This small species is clearly distinct from *Ulmus speciosa* both in shape and size. In his discussion of the flora of the John Day Basin,[1] Knowlton found a corresponding difference between the true *Ulmus speciosa* and a smaller form which he called *Ulmus newberryi.* The latter differs from *Ulmus tanneri* in being notably lanceolate, and is clearly distinct from it. The small leaves figured as *Ulmus speciosa* by Newberry, though incomplete, more closely resemble *Ulmus tanneri* in shape than they do *Ulmus newberryi* as figured by Knowlton. In any case *Ulmus tanneri* appears to possess specific distinction from both *Ulmus speciosa* and *U. newberryi.*

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 11, and 13.

Collection.—Walker Museum, University of Chicago.

Family MORACEAE

FICUS PLANICOSTATA LESQUEREUX (?)

Ficus planicostata, Lesquereux, *Tertiary Flora,* p. 201, Pl. 31, Figs. 1–8, 10–12.
Ficus planicostata, Newberry, *U.S.G.S. Mon. 35,* p. 88, Pl. XLVI, Fig. 2.

There is a single specimen in the collections which is identical in appearance with the specimen figured by Newberry from Bridge Creek, Ore. Whether either of these specimens should be referred to *Ficus planicostata* is somewhat doubtful, as both are imperfectly preserved.

Occurrence.—Multnomah County, Ore., Locality No. 15.

Collection.—Walker Museum, University of Chicago.

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[1] *U.S.G.S. Bull. 204,* p. 54, Pl. IX, Fig. 4.

Order RANUNCULALES

Family MAGNOLIACEAE

LIRIODENDRON TRILOBATA Chaney, n.sp.

Plate XIV, Figure 4

Description.—Leaf broadly cordate, primarily three-lobed, the lateral lobes truncate to concave, the main lobe double, its two concave secondary lobes meeting in a distinct point at the apex of the leaf. Margin sinuate, with broad curving sinuses between the main lobe and the lateral lobes. Palmately three-nerved, the lateral primaries ending in the concave tips of the lateral lobes, the central primary in the pointed apex; secondaries distinct, branching into a camptodrome network at the margin; nervilles dendritic. Length 5 cm., width 6.8 cm.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

MAGNOLIA OREGONIANA Chaney, n.sp.

Plate XV, Figure 1

Description.—Leaves ovate, 8.5 to 12 cm. in length (estimated), and 4.3 to 6 cm. in width. Margin entire, broadly undulate. Texture subcoriaceous. Midrib stout and straight; secondaries strong, leaving the midrib alternately at an angle of about 45° and curving upward gradually toward the margin of the leaf, camptodrome; finer nervation producing a close and complex network.

The two specimens representing this species each lack the distal end, and the petioles also are missing.

Occurrence.—Multnomah County, Ore., Localities Nos. 8 and 11.

Collection.—Walker Museum, University of Chicago.

Family LAURACEAE

LAURUS SIMILIS Knowlton,

Laurus similis, Knowlton, *20th Ann. Rept. U.S. Geol. Surv.,* Part III, p. 48, Pl. V, Figs. 1–4.

Numerous specimens from several localities are referred to this species. They range in size from 7.5 to 12 cm. long and from 2.3 to 4 cm. wide.

Occurrence.—Multnomah County, Ore., Localities Nos. 3, 5, 6, and 8; Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

OREODAPHNE LITHAEFORMIS Lesquereux (?)

Oreodaphne lithaeformis, Lesquereux, *Proc. U.S. Nat. Mus.,* XI, 30, Pl. 14, Fig. 4.

The general shape, margin, and nervation of the single specimen secured suggest its relation to *Oreodaphne lithaeformis.* In absence of more complete material, some doubt must remain regarding the certainty of this reference.

Occurrence.—Multnomah County, Ore., Locality No. 15.

Collection.—Walker Museum, University of Chicago.

LAUROPHYLLUM OREGONENSIS Chaney, n.sp.

Plate XXI, Figures 1 and 2

Description.—Leaves ovate-lanceolate, with base subcordate. Margin undulate, serrate-toothed throughout. Nervation distinct, seven or eight pairs of secondaries branching outward from the stout midrib and curving gradually upward, in some cases bifurcating; nervilles not conspicuous. Length 9.2 to 11 cm., width 3.4 to 5.3 cm.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

Order ROSALES

Family HAMAMELIDACEAE

LIQUIDAMBAR EUROPAEUM Al. Br.

Liquidambar europaeum, Lesquereux, *Cretaceous and Tertiary Flora,* p. 159, Pl. 32, Fig. 1.

Liquidambar europaeum, Newberry, *U.S.G.S. Mon. 35,* p. 100, Pl. XLVII, Figs. 1–3.

Liquidambar europaeum, Knowlton, *U.S.G.S. Bull. 204,* p. 62.

The precise relation of this species to its European equivalent and to some other American species is considered by Knowlton to be still in doubt. Specimens from the Eagle Creek collections closely resemble the material figured by Newberry from the Bridge Creek locality of the John Day Basin.

Occurrence.—Multnomah County, Ore., Localities Nos. 4 and 7.

Collection.—Walker Museum, University of Chicago.

LIQUIDAMBAR PACHYPHYLLUM Knowlton

Plate XV, Figures 2 and 3

Liquidambar pachyphyllum, Knowlton, *U.S.G.S. Bull. 204,* p. 63, Pl. IX, Fig. 1.

Description.—Leaves 6.5 to 7.5 cm. long, about 7 cm. broad, five-lobed with a distinctly cordate base; lobes ovate-lanceolate, acutely pointed, the central lobe conspicuously longest. Margin serrate throughout, the teeth prominent and upward pointing. Primary nerves stout; secondaries distinct, camptodrome.

Numerous specimens, many of them well preserved, are included in the collections from several localities.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 11, 13, 14, and 15.

Collection.—Walker Museum, University of Chicago.

LIQUIDAMBAR CALIFORNICUM Lesquereux

Liquidambar californicum, Lesquereux, *Mem. Mus. Comp. Zoöl.,* VI, 14, Pl. VI, Fig. 7c; Pl. VII, Figs. 3, 6.

A single specimen is referred to this species on the basis of its trilobate character. In addition, the asymmetrical base of this specimen is like those in the specimens figured by Lesquereux. It resembles ***Liquidambar pachyphyllum***, but the lobes are fewer and shorter, and the margin is more finely denticulate.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

LIQUIDAMBAR ACUTILOBUM Chaney, n.sp.

Plate XV, Figure 4.

Description.—Leaf palmately five-lobed, the lobes elongate-lanceolate with wide triangular sinuses between. Primary nerves well developed, the lower lateral pair at right angles to the central nerve, the upper lateral pair diverging from the central nerve at an angle of 45°; secondaries mostly alternate, indistinct. Margin finely and rather sparsely serrate. Base incomplete, apparently broadly cordate. Length about 6 cm., width 8 cm.

This species, represented by the specimen figured and several fragments, resembles *L. pachyphyllum* in its general size and strong nervation, but has markedly different proportions, more acute lobes, and margin more obscurely toothed.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

Family PLATANACEAE

PLATANUS ASPERA Newberry

Platanus aspera, Newberry, *Proc. U.S. Nat. Mus.*, V, 509.

Platanus aspera, *U.S.G.S. Mon. 35*, p. 102, Pl. XLII, Figs. 1–3; Pl. XLIV, Fig. 5; Pl. LIX, Fig. 3.

Several leaves are referred to this species on the basis of their coarse dentation and indefinitely three- to five-lobed character. The teeth of the Eagle Creek specimens are coarser and show less tendency to be compound than those in Newberry's figures, but this may be considered to be no more than an individual variation.

Occurrence.—Multnomah County, Ore., Localities Nos. 8, 11, and 15.

Collection.—Walker Museum, University of Chicago.

Family ROSACEAE

CRATAEGUS HETERODENTATA Chaney, n.sp.

Plate XVI, Figures 1 and 2

Description.—Leaves elongate-oval, broadly wedge-shaped at the base, with acuminate tips. Margin entire at the base, lobately serrate above, the teeth projecting mostly outward, sharply pointed, with several smaller teeth below them, and broad triangular sinus-like notches above them. Nervation strong, about twelve pairs of secondaries branching off from the midrib at an angle of 40°, and curving upward slightly to terminate in the large teeth;

tertiaries large near the margin, terminating in the smaller teeth, and elsewhere forming with the nervilles a polygonal, somewhat dendritic, network. Length 6 to 8 cm., width up to 4 cm.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

CRATAEGUS PACIFICA Chaney, n.sp.

Plate XVII, Figure 1

Description.—Leaf broadly oval to orbiculate, broadly wedge-shaped at the base, primarily three-lobed, the central lobe with a pair of lateral lobes, giving the leaf a five-lobed character. Midrib stout, greatly diminishing toward the apex; secondaries numerous, various small pairs ending in the finer nervation of the leaf, two conspicuous pairs leaving the midrib alternately, the lower pair rising well above the base of the leaf and terminating in the lateral lobes, the upper pair arising somewhat over halfway out toward the tip and terminating in the small lateral lobes of the central lobe. Lateral lobes obtusely acuminate, separated from the central lobe by broad sinuses which reach nearly halfway in to the midrib from the tips of the lobes, central lobe larger, nearly equally three-lobed at the apex: Margin of the lobes serrate, especially that of the central lobe. Length 4.2 cm., width 3.4 cm.

The single specimen resembles *Crataegus imparilis*,[1] but the following differences may be noted: (1) the margin of *C. pacifica* is conspicuously rather than obscurely dentate, as in *C. imparilis;* (2) the main ribs of the lateral lobes of *C. pacifica* are secondaries, arising from the midrib well above the basal end, while *C. imparilis* is palmately three-nerved. In addition, features which may represent only an individual variation are the broader and shallower character of the main sinuses, the lack of small side lobes on the lateral lobes, and the larger size of the leaf in *C. pacifica*.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

PRUNUS sp.

Plate XVII, Figure 2

Description.—Leaf ovate-acuminate, with a maximum width of a little over 3 cm. and a length of about 7 cm. (base missing). Margin finely and rather obtusely serrate. Midrib strong; secondaries coming out at an angle of 60° and turning distinctly upward in the outer part of the leaf, camptodrome; tertiaries distinct, leaving the secondaries at approximately right angles.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

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[1] Knowlton, *U.S.G.S. Bull 204*, p. 66, Pl. X, Fig. 2.

Family LEGUMINOSAE

CERCIS OREGONENSIS Chaney, n.sp.

Plate XVI, Figures 3 and 4

Description.—Leaves broadly ovate, the base subtruncate to broadly cuneate, gradually narrowing to an acuminate or rounded apex. Margin entire, with broad and shallow crenulations. Primary nerves five, rising in the cuneate extension of the base; the lower lateral pair parallel the margin until they branch and lose their identity in the lower half of the leaf; upper lateral nerves approximately equal to the central nerve in size, extending up with an angle of 15° between them and the central nerve, gradually paralleling the margin and becoming camptodrome in the upper half of the leaf; central nerve strong throughout, changing its direction slightly in the upper half where secondaries branch off; secondaries branching, camptodrome; nervilles numerous, indistinct. Length 5.3 to 8.5 cm., width 4 to 6.5 cm.

From another locality than that furnishing the leaves has been secured what resembles a leguminous pod. The basal portion only is preserved, but this has the general shape of the fruit of *Cercis*. Length 3.5 cm., breadth 8 cm. A single seedlike object, oval in shape and 6 mm. long, is contained in this fragment.

Occurrence.—Multnomah County, Ore., Locality No. 4 (leaves); Hood River County, Ore., Locality No. 16 (pod).

Collection.—Walker Museum, University of Chicago.

LEGUMINOSITES COLUMBIANUS Chaney, n.sp.

Plate XVII, Figure 3

Description.—Leaflets elongate-obovate, with a cordate base and subtruncate apex. Main nerve very strong; secondaries indistinct, branching off at an angle of about 15°. Length 3 cm., width 8 mm.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

Order SAPINDALES

Family ANACARDIACEAE

RHUS TYPHINOIDES Lesquereux (?)

Rhus typhinoides, Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, 29, Pl. IX, Figs. 1–6.

A single incomplete specimen resembles this species, but for lack of satisfactory material the reference must remain doubtful.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

RHUS BENDIREI Lesquereux (?)

Rhus bendirei, Lesquereux, *Proc. U.S. Nat. Mus.*, IX, 15, Pl. IX, Fig. 2.

The single specimen represented bears a close resemblance to this species, but is too poorly preserved to make certain its reference to it.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

Family ACERACEAE

ACER AQUILUM Chaney, n.sp.

Plate XVII, Figures 4 and 5; Plate XVIII, Figure 1; Plate XIX, Figure 1

Description.—Leaves palmately lobed, with base deeply to shallowly cordate, distinctly asymmetrical; central lobe broadly acuminate; one pair of lateral lobes which may be nearly as long as the central lobe, of similar shape and commonly directed outward; one to three pairs of lateral lobes at the base, usually small and inconspicuous. Margin coarsely dentate throughout, the teeth broad, sharply pointed, and directed outward. Palmately five- to nine-nerved, the upper pair of lateral nerves with an angle of 40° to 50° between them and the central nerve and terminating in the large lateral nerves; lower lateral nerves directed outward, and terminating in the relatively short basal lobes which may be nothing more than large marginal teeth; secondaries numerous especially from the three main primaries, terminating in the marginal teeth; nervilles well developed. Length from 7.5 to 15 cm., or even more in the case of some fragmentary specimens, width from 5 to 11 cm. Most of the specimens are of the smaller dimensions, but there is a gradation from these to the large. Figure 1, Plate XIX, represents a specimen in which the three main lobes are more lanceolate than in the remainder.

I have felt considerable hesitation, because of the lack of the type specimens of *Acer bendirei*, at the separation of the Eagle Creek material from that species. However, Lesquereux' description of the type specimens and his figures,[1] as well as those of later authors, show sufficient differences to justify naming *Acer aquilum* as a distinct species. *Acer bendirei* is palmately three-nerved, while *Acer palmatum* is five- to nine-nerved. The lobes of *A. aquilum* are typically broad-acuminate rather than lanceolate as in *A. bendirei*, and the main lateral pair is more nearly equal in size to the central lobe than in *A. bendirei;* further, these lobes are directed outward rather than upward, and are rarely recurved. The basal lobes, while not commonly distinct in *A. aquilum*, are entirely lacking in *A. bendirei* due to the absence of basal primary nerves. The petioles, which are described and conspicuously figured under *A. bendirei*, are entirely lacking in *A. aquilum* except for a short fragment in one specimen, indicating that the petioles of *A. aquilum* were less stout.

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[1] *Proc. U.S. Nat. Mus.*, XI, 14, Pl. V, Fig. 5; Pl. VI, Fig. 1; Pl. VII, Fig. 1; Pl. VIII, Fig. 1.

Occurrence.—Multnomah County, Ore., Localities Nos. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, and 15; Hood River County, Ore., Locality No. 16; Skamania County, Wash., Localities Nos. 18 (?) and 19.

Collection.—Walker Museum, University of Chicago.

ACER COMPLETUM Chaney, n.sp.

Plate XVIII, Figure 2

Description.—Fruit varying from 2.5 to 4 cm. in length. Seed ovate, 3 mm. long and 2 mm. broad, attached without constriction to the wing which broadens to over a centimeter in width in its distal half. Nerves of the wing distinct, bifurcating several times.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

ACER BOLANDERI Lesquereux

Acer bolanderi, Lesquereux, *Mem. Mus. Comp. Zoöl.*, VI, 27, Pl. VII, Figs. 7-11.

Several specimens show the general features of this species with certain minor variations.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

ACER MINUTIFOLIA Chaney, n.sp.

Plate XIX, Figure 2

Description.—Leaf distinctly trilobate, with a broadly cordate base. Lateral lobes short, separated from the main lobe by open and rounded sinuses. Palmately three-nerved, possibly five-nerved, the lateral nerves branching out at an angle of 40°; secondaries few, terminating the marginal teeth which are few in number and coarsely acute. Length 4.5 cm., width 4.2 cm.

It does not appear likely that this specimen represents a small leaf of *A. aquilum*, for its proportions are distinctly different, and the marginal teeth are acute and few in number.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

Order MALVALES

Family TILIACEAE

TILIA PEDUNCULATA Chaney, n.sp.

Plate XIX, Figures 3 and 4

Description.—Pedunculate bracts elongate-oblong, with a rounded apex, base commonly rounded subcordate, in one specimen broadly wedge-shaped. Central nerve distinct, bifurcating in the distal half in one specimen; nervilles distinct, irregularly branching, reticulate. Length 6.6 cm. to 8 cm. (estimated), width 1 to 1.3 cm.

These characteristic remains from several localities are referred to *Tilia* because of their shape and nervation. None have been found with the seed attached.

Occurrence.—Multnomah County, Ore., Localities Nos. 11, 13, and 14.

Collection.—Walker Museum, University of Chicago.

Order UMBELLALES

Family CORNACEAE

NYSSA CRENATA Chaney, n.sp.

Plate XX, Figures 1, 2, and 3

Description.—Leaves oval, narrowing to a bluntly rounded apex, or possibly to an acuminate apex in some specimens in which the tip of the leaf is missing, base narrowly rounded. Margin entire, undulate, with shallow crenate lobes in the upper portion of the smaller leaves, distinctly and obtusely toothed in a large leaf, the teeth large and pointing outward. Nervation very distinct, about eight pairs of secondaries leaving the midrib at an angle of 35°, coming to the margin opposite the lobes or teeth, irregularly camptodrome with numerous arching tertiaries. Length 9 to 13 cm., width 5 to 7 cm.

Occurrence.—Multnomah County, Ore., Localities Nos. 8 and 13.

Collection.—Walker Museum, University of Chicago.

Order GENTIANALES

Family OLEACEAE

FRAXINUS (?) sp.

Plate XX, Figure 4

Description.—Leaf ovate-elongate. Margin finely serrate, with teeth acute and recurved. Secondaries branching off at about right angles, and curving up to the margin, camptodrome; tertiaries few, distinct. Length 6 cm. (estimated), width 2.5 cm.

A single incomplete but well-preserved specimen is doubtfully referred to this genus.

Occurrence.—Multnomah County, Ore., Locality No. 4.

Collection.—Walker Museum, University of Chicago.

INCERTAE SEDIS

PHYLLITES TANNERI Chaney, n.sp.

Plate XXII, Figure 1

Description.—Leaf ovate or obovate, narrowing to a wedge-shaped base. Margin entire, undulate. Midrib very strong and curving; secondaries branching off irregularly, camptodrome; petiole stout, 1.4 cm. in length. Length (of the basal portion) 8 cm., width 5.6 cm.

This is represented by a single leaf of which only the basal portion is preserved in the specimen.

Occurrence.—Multnomah County, Ore., Locality No. 8.

Collection.—Walker Museum, University of Chicago.

PHYLLITES sp.

Plate XIV, Figure 3

The fragment of the tip of an unknown leaf is included in the collections from Locality No. 4.

CARPOLITHUS RUGOSUS Chaney, n.sp.

Plate XXII, Figures 2 and 3

Description.—Nut globular, tapering slightly to the point of attachment with the stout stem. Surface with distinct meridianal grooves; possibly this rough exterior represents the husk, as smaller nuts of similar size and shape, with smooth exteriors, have been found. All the rugose specimens are appressed, due perhaps to changes during fossilization or burial. Diameter from 1.5 to 2.8 cm.

Occurrence.—Multnomah County, Ore., Localities Nos. 4, 11, and 12.

Collection.—Walker Museum, University of Chicago.

CARPOLITHUS BONNEVILLENSIS Chaney, n.sp.

Plate XXII, Figure 4

Description.—Fruit oval, 9 mm. in length, attached to a broad short stem. The outer husk or fleshy portion incloses an elongate seed 6 mm. in length. The relation of the two individuals suggests their attachment in a cluster.

Occurrence.—Multnomah County, Ore., Locality No. 11.

Collection.—Walker Museum, University of Chicago.

SCALE

Plate XXII, Figure 5

A characteristic scale of unknown affinity is worthy of description. What appears to be the base is truncate to bluntly rounded, gradually increasing toward the distal end where the margin is distinctly five-toothed. Five nerves, of which the central one is the most prominent, extend from the base and terminate in the teeth.

Occurrence.—Multnomah County, Ore., Localities Nos. 6, 7, and 11; Hood River County, Ore., Locality No. 16.

Collection.—Walker Museum, University of Chicago.

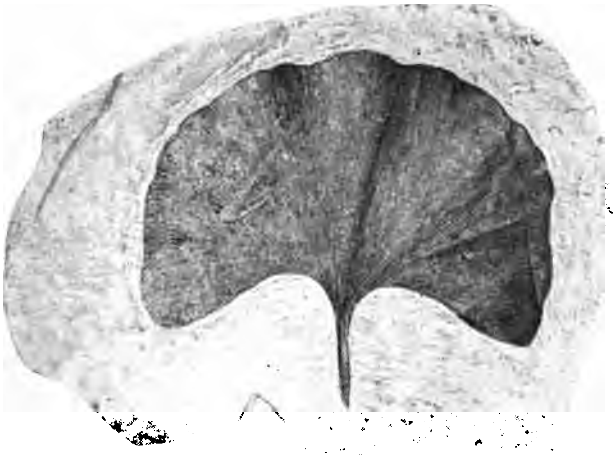
PLATE V

FIG. 1.—*Ginkgo adiantoides* Heer (*Walker Mus. Cat.*, No. 22363).

FIG. 2.—*Picea* (?) sp. (*Walker Mus. Cat.*, No. 22343).

FIGS. 3, 4.—*Pinus knowltoni* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22349, 22350).

FIG. 5.—*Sabalites* sp. (*Walker Mus. Cat.*, No. 22410).



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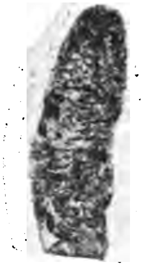

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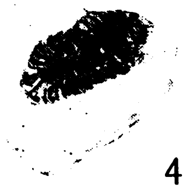

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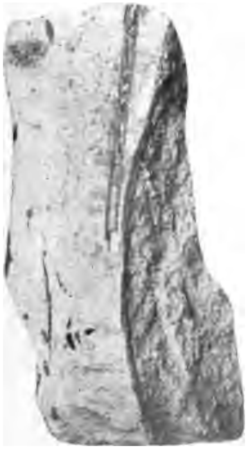

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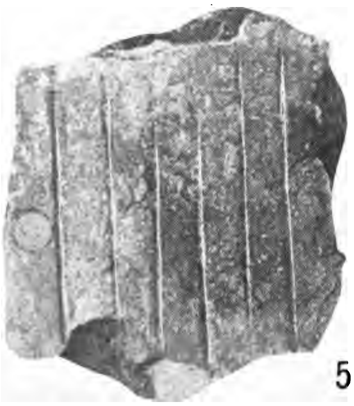

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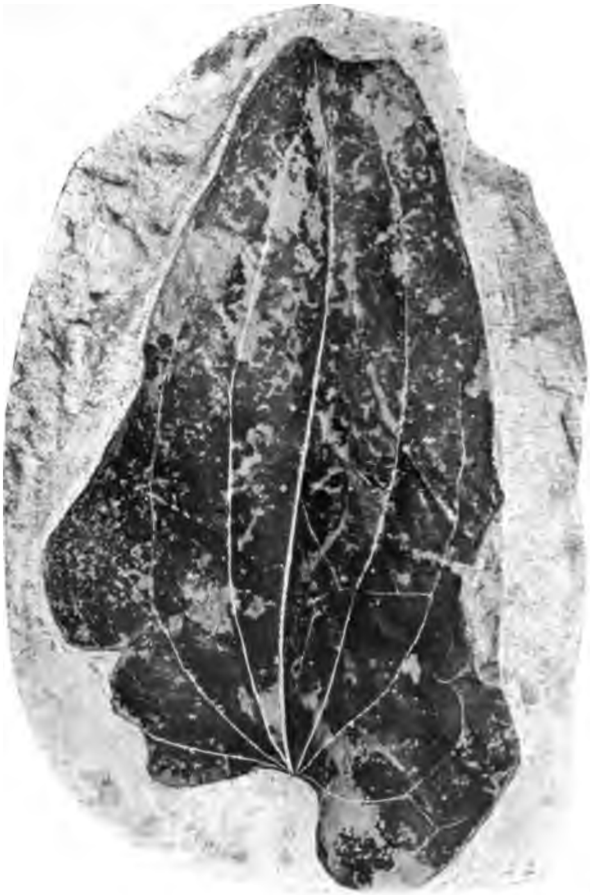
PLATE VI

FIG. 1.—*Smilax magna* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22309).

FIG. 2.—*Cyperacites angustifolia* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22325).

FIGS. 3, 4.—*Phyllites minuta* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22411, 22412).



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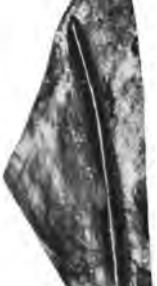

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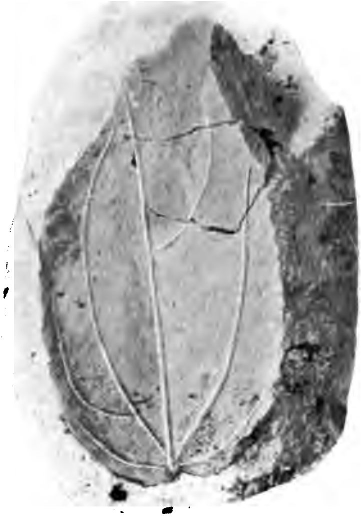
PLATE VII

FIGS. 1, 2.—*Populus Zaddachi* Heer (*Walker Mus. Cat.*, Nos. 22333, 22334).

FIGS. 3, 4.—*Populus delicatus* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22370, 22371).

FIG. 5.—*Myrica pacifica* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22394).



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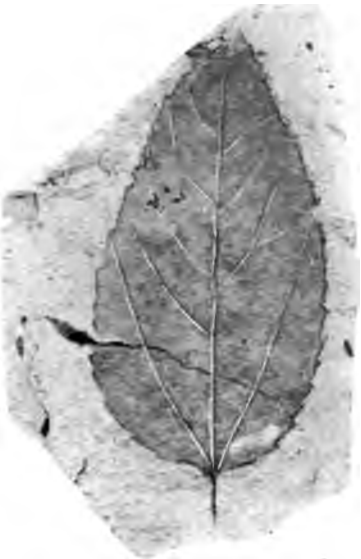

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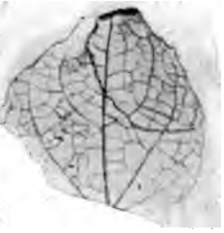

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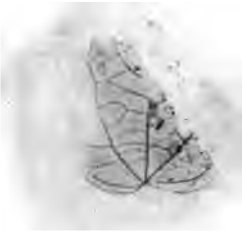

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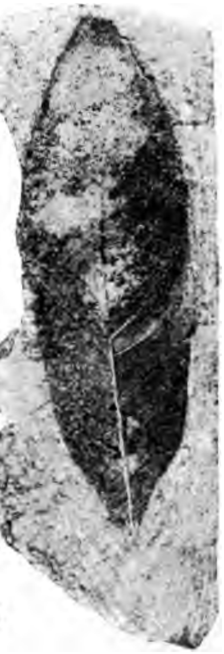

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PLATE VIII

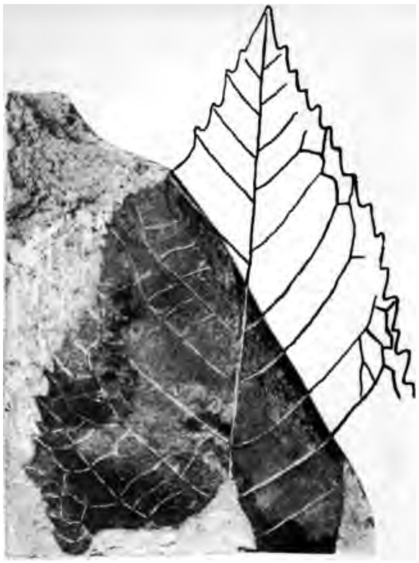
FIG. 1.—*Hicoria dentata* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22372) (figure reconstructed to show curled-over tip of leaf).

FIG. 2.—*Hicoria orientalis* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22365).

FIG. 3.—*Hicoria pecanoides* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22369).

FIG. 4.—*Hicoria williamsi* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22397).

PLATE VIII



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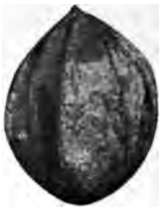

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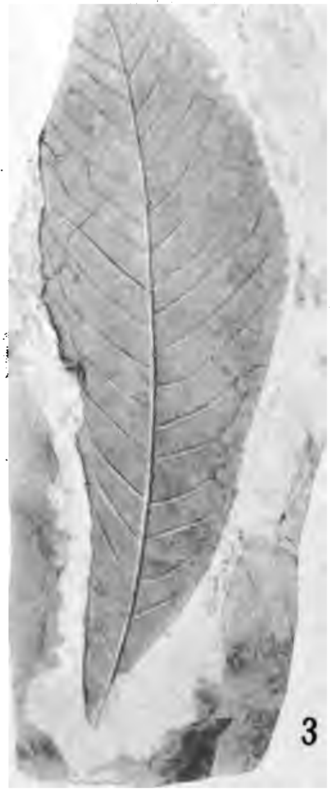

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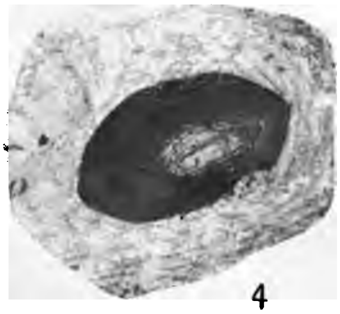

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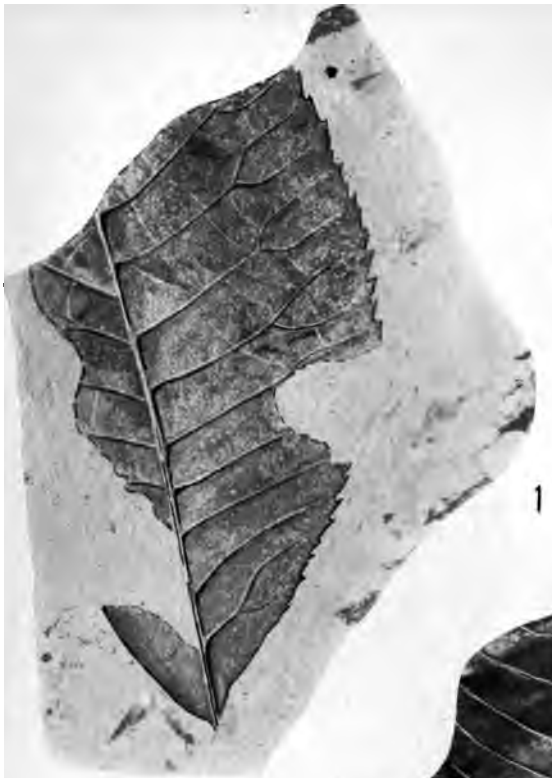
PLATE IX

FIGS. 1, 2.—*Juglans ovoides* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22314, 22315).

FIG. 3.—*Betula nanita* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22373).

FIG. 4.—*Corylus maxicarpus* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22346).



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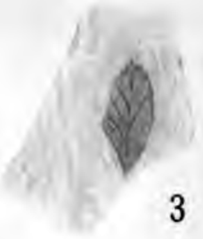

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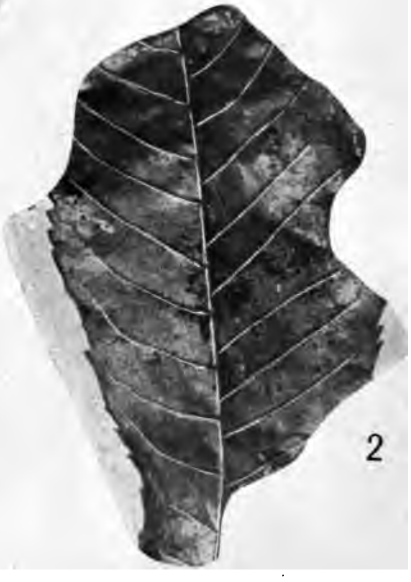

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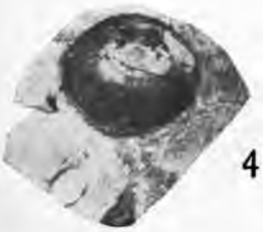

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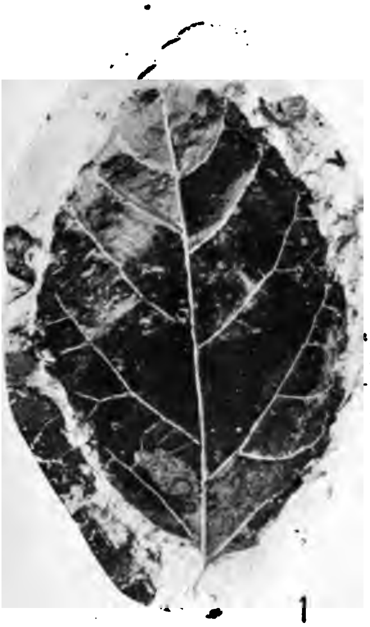
PLATE X

FIGS. 1, 2.—*Alnus oregoniana* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22339, 22340).

FIGS. 3, 4, 5.—*Castanea* (?) *radiata* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22321, 22331, 22332).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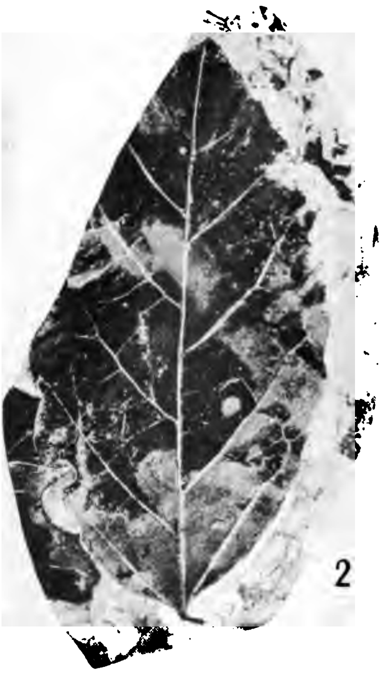
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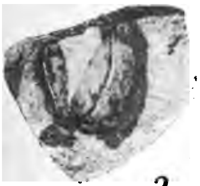
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PLATE XI

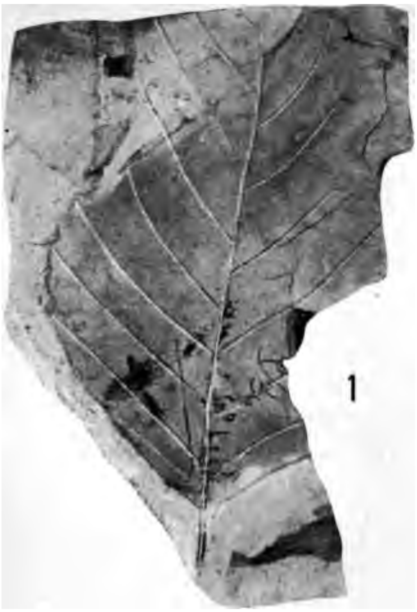
(Slightly reduced)

FIG. 1.—*Fagus* (?) *bonnevillensis* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22385).

FIGS. 2, 3.—*Quercus fosteri* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22329, 22330).

FIG. 4.—*Quercus simplex* Newberry (*Walker Mus. Cat.*, No. 22395).

FIG. 5.—*Quercus cowlesi* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22384).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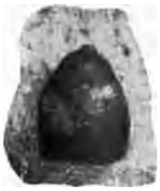
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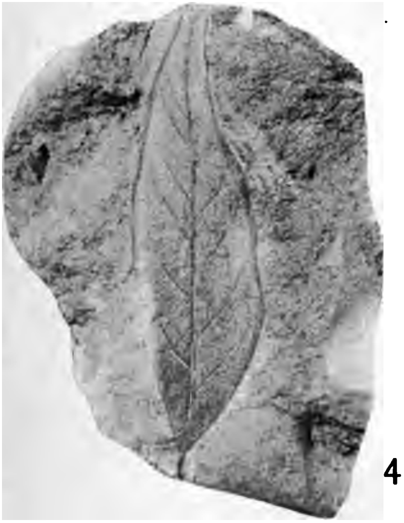
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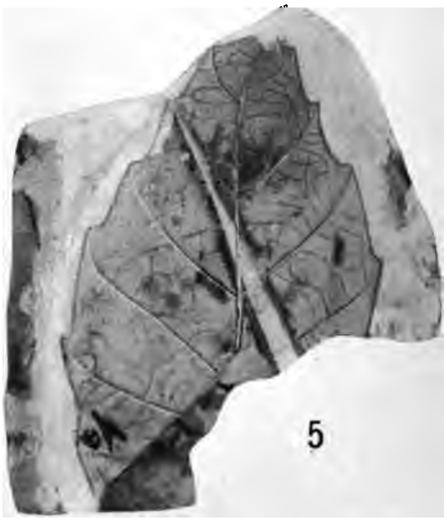
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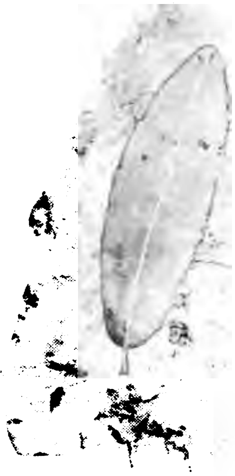
PLATE XII

(Slightly reduced)

FIG. 1.—*Quercus simulata* Knowlton (*Walker Mus. Cat.*, No. 22354).

FIGS. 2, 3.—*Quercus washingtonia* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22401, 22402).

FIG. 4.—*Quercus bretzi* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22403).



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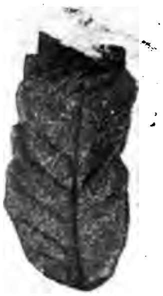

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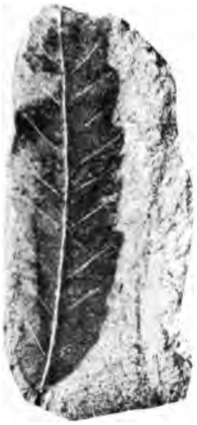

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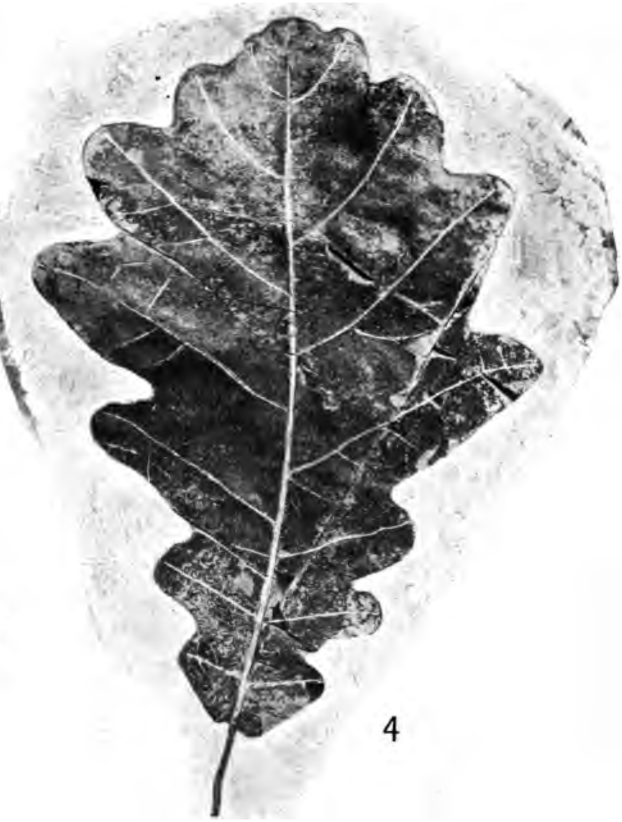

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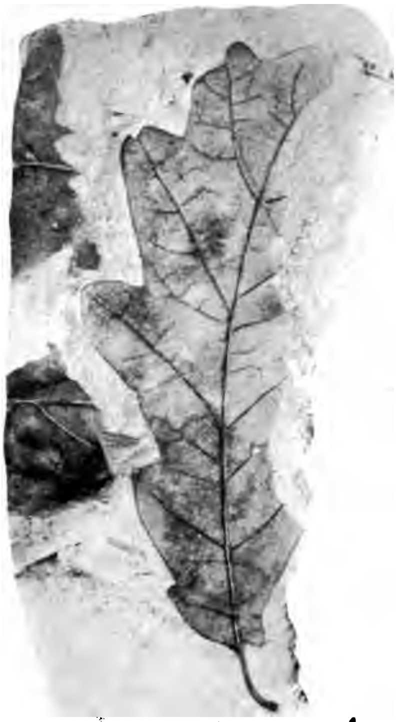
PLATE XIII

(Slightly reduced)

Figs. 1, 2.—*Quercus columbiana* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22362, 22323).

Fig. 3.—*Quercus bretzi* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22404).

Fig. 4.—*Quercus* sp. (*Walker Mus. Cat.*, No. 22344).



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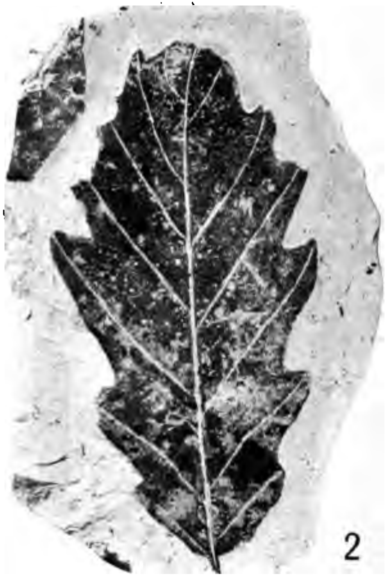

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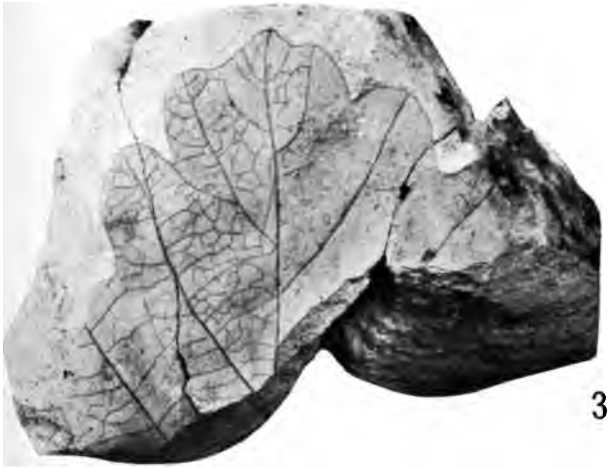

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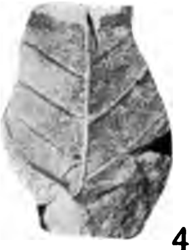

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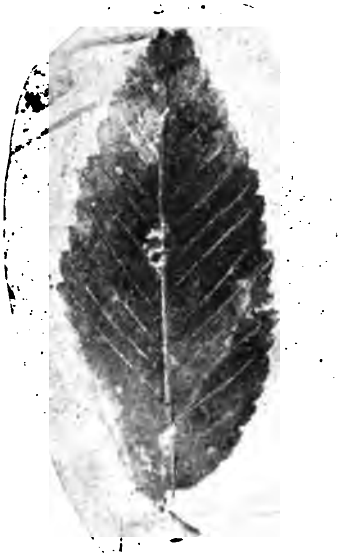
PLATE XIV

FIGS. 1, 2.—*Ulmus tanneri* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22336, 22337).

FIG. 3.—*Phyllites* sp. (*Walker Mus. Cat.*, No. 22406).

FIG. 4.—*Liriodendron trilobata* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22358).



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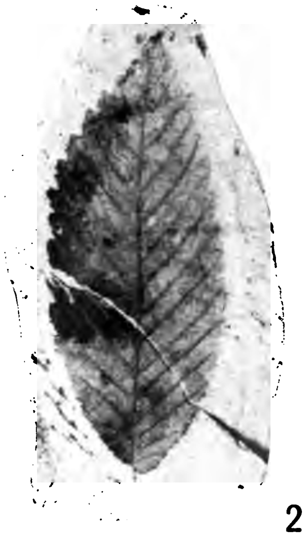

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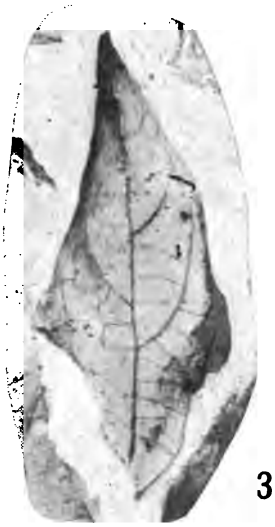

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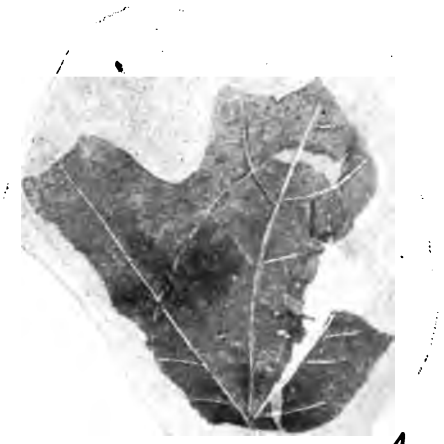

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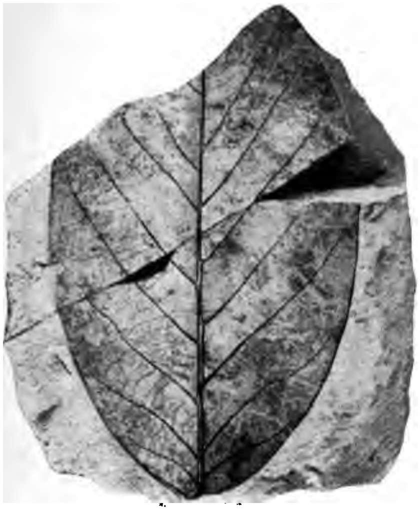
PLATE XV

(Reduced one-third)

FIG. 1.—*Magnolia oregoniana* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22319).

FIGS. 2, 3.—*Liquidambar pachyphyllum* Knowlton (*Walker Mus. Cat.*, Nos. 22300, 22301).

FIG. 4.—*Liquidambar acutilobum* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22360).



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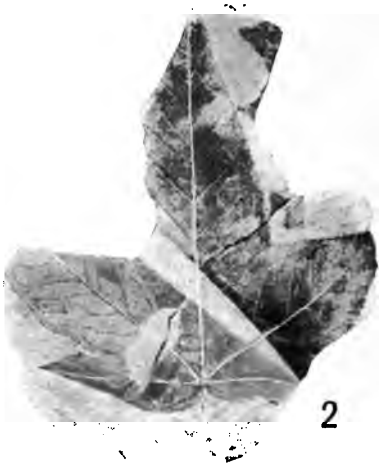

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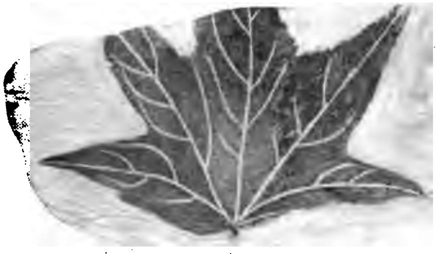

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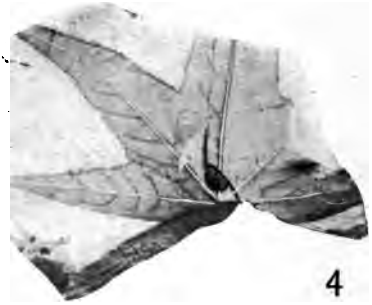

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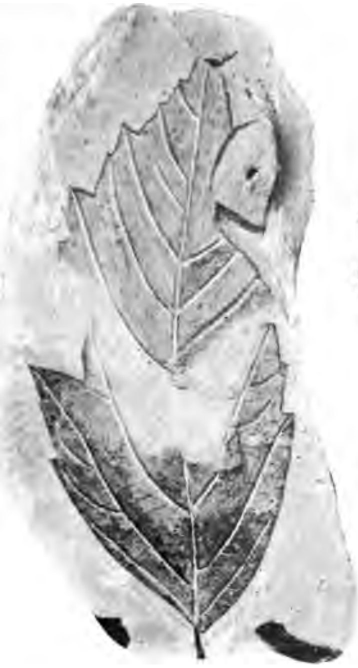
PLATE XVI

FIGS. 1, 2.—*Crataegus heterodentalis* Chaney, n.sp. Walker Mus. Coll. Nos. 22357, 22358.

FIGS. 3, 4.—*Cercis oregonensis* Chaney, n.sp. Walker Mus. Coll. Nos. 22367, 22368.



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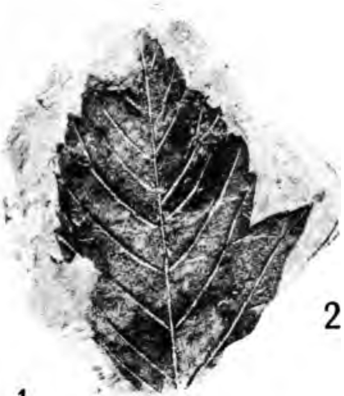

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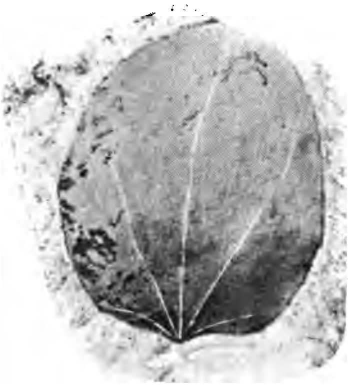

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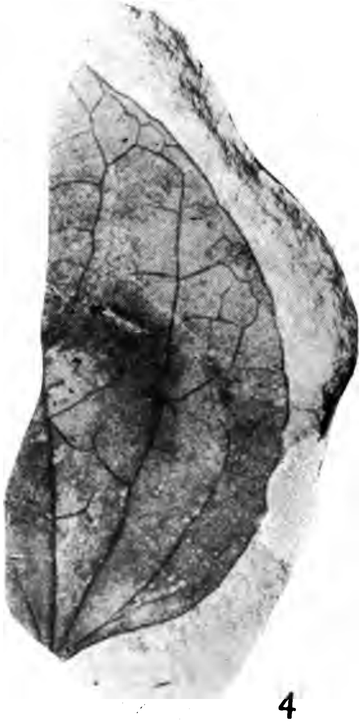

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PLATE XVII

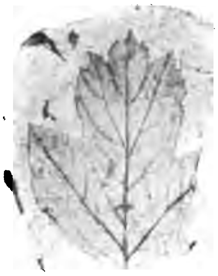
(Reduced one-fourth)

FIG. 1.—*Crataegus pacifica* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22359).

FIG. 2.—*Prunus* sp. (*Walker Mus. Cat.*, No. 22324).

FIG. 3.—*Leguminosites columbianus* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22398).

FIGS. 4, 5.—*Acer aquilum* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22416, 22417).



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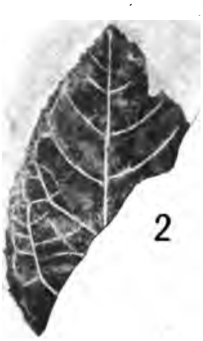

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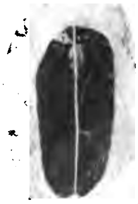

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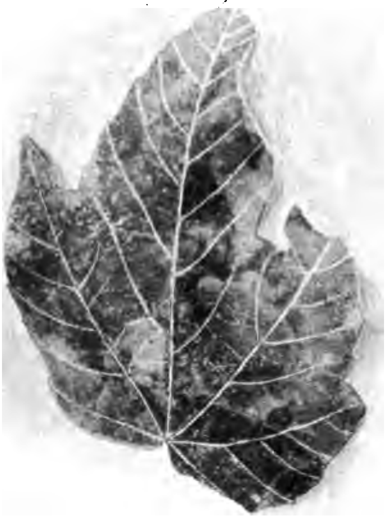

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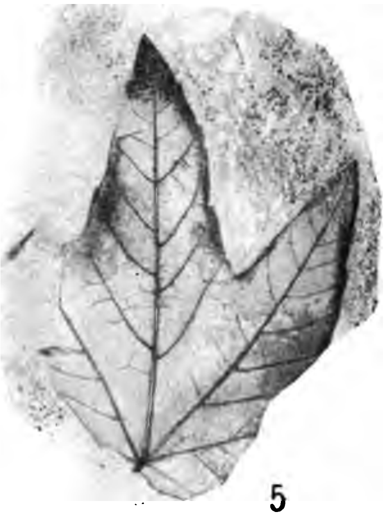

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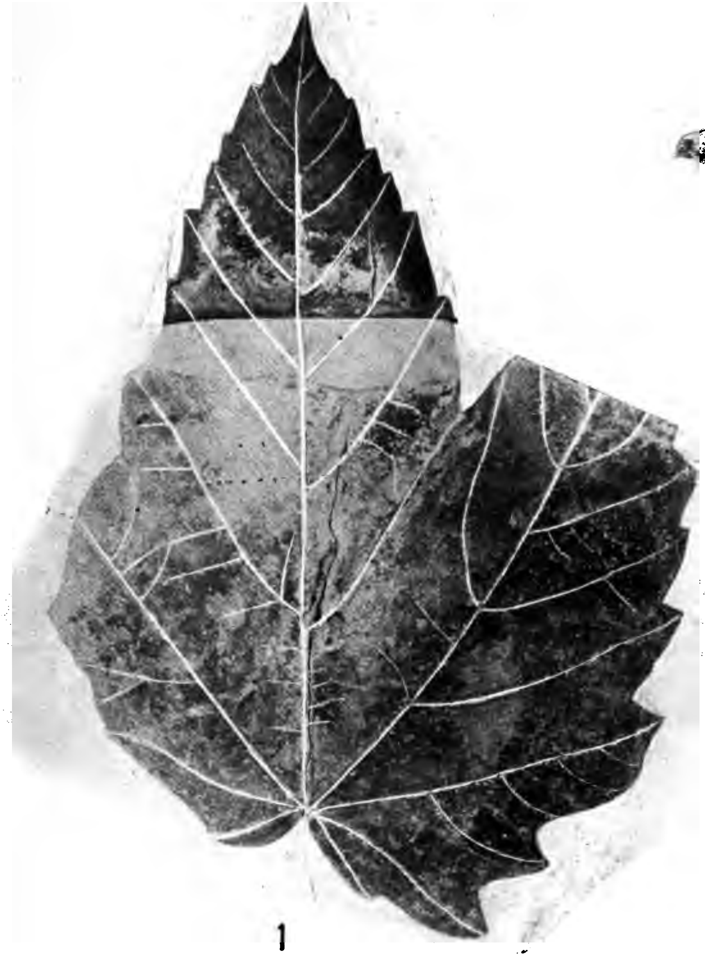
PLATE XVIII

(Reduced one-fifth)

FIG. 1.—*Acer aquilum* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22418).
FIG. 2.—*Acer completum* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22302).



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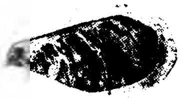

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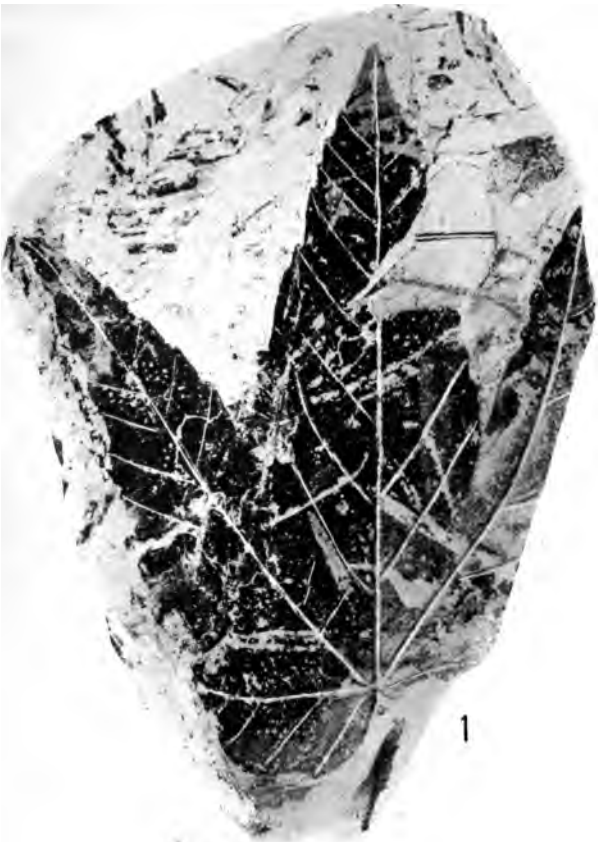
PLATE XIX

FIG. 1.—*Acer aquilum* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22419).

FIG. 2.—*Acer minutifolia* Chaney, n.sp. (*Walker Mus. Cat.*, No. 22392).

FIGS. 3, 4.—*Tilia pedunculata* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22379, 22380).

PLATE XIX



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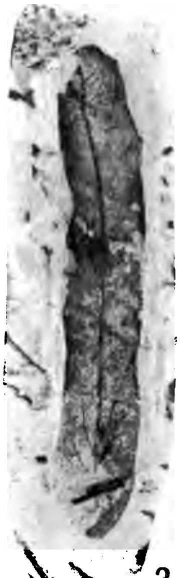

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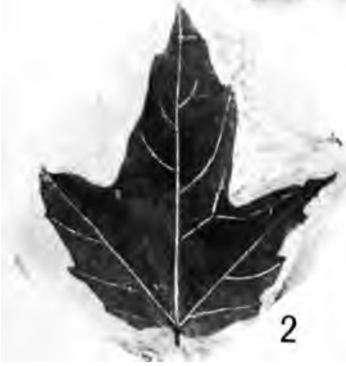

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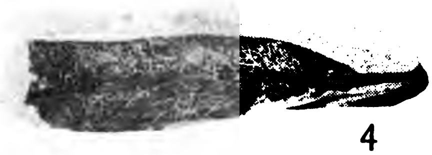

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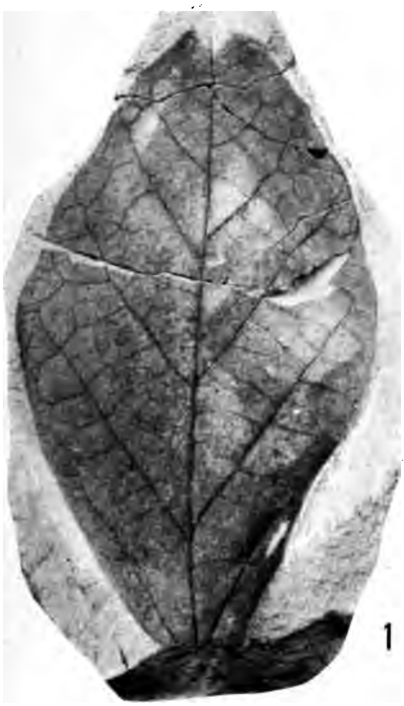
PLATE XX

(Slightly reduced)

FIGS. 1, 2, 3.—*Nyssa crenata* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22381, 22382, 22383).

FIG. 4.—*Fraxinus* (?) sp. (*Walker Mus. Cat.*, No. 22391).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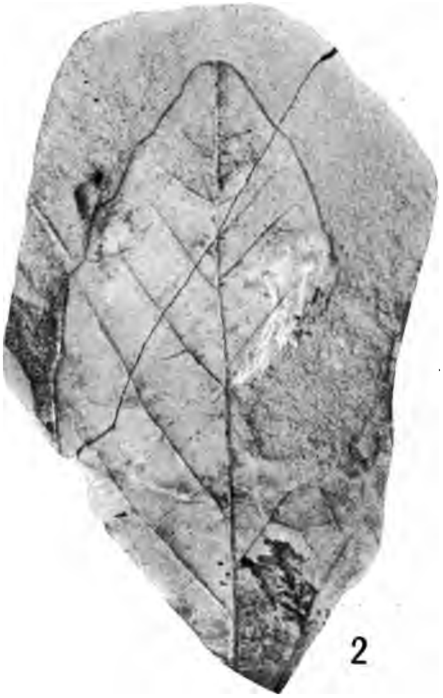
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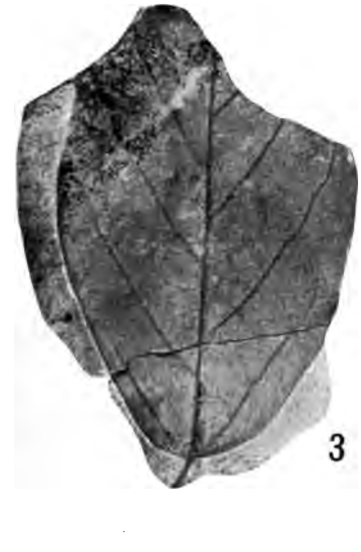
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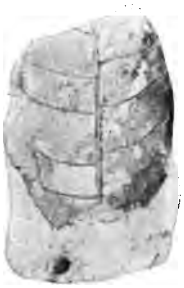
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PLATE XXI

(Slightly reduced)

FIGS. 1, 2.—*Laurophyllum oregonensis* Chaney, n.sp. (*Walker Mus. Cat.*, Nos. 22393, 22420).